****

**REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**SOLAR PV SYSTEM INSTALLATION TECHNOLOGY**

**KNQF LEVEL 5**

**PROGRAMME ISCED CODE: 0713 454 A**

**First Published** 2024

First Revision ……

Second Revision 2025

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# FOREWORD

Provision of quality education and training is fundamental to the Government’s overall strategy for socio-economic development. Quality education and training contribute to achievement focused on Kenya’s development blueprint and sustainable development goals.

Reforms in the education and training sector are necessary for achievement of Kenya Vision 2030 and meeting the provisions the Constitution of Kenya. The education sector had to be aligned to the Constitution and this resulted in formulation of the Policy Framework for Reforming Education and Training (Sessional Paper No. 1 of 2019). A key feature of this policy is the 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 mode of delivery that allows for multiple entry and exit in TVET programs.

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.

It is my conviction that this curriculum will play a great role towards development of competent human resource for the Electrical Engineering sector’s growth and sustainable development.

**PRINCIPAL SECRETARY**

**STATE DEPARTMENT FOR TVET**

**MINISTRY OF EDUCATION**

**PREFACE**

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

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

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

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

# 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 …….. 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 Electricity and Energy 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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**ABBRECIATIONS AND ACRONYMS**

CAD Computer Aided Design

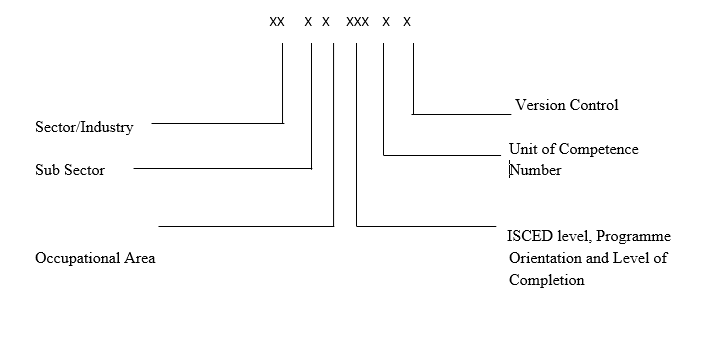
IEEE Institute of Electrical and electronics Engineers

PPE Personal Protective Equipment

PV Photo Voltaic

TVETA Technical and Vocational Education and Training Authority

**KEY TO ISCED UNIT CODE**



**OVERVIEW**

Solar PV System Installaer Level 5 qualifications consist of competencies that an individual must achieve to perform solar installation activities. It involves performing Electrical installation, DC Solar PV Systems Installation, Solar Water Pump System Installation, Electrical installation, Solar PV systems, Solar water pump system, Electrical installation I, Solar PV Systems Design, Electrical installation II, Solar PV Pumps System Installation and Security systems installation

**Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **MODULE ONE** | | | |
| **Unit Code** | **Units Title** | **Unit Duration (Hours)** | **Credit Factor** |
| 0713 251 03A | Electrical installation | 64 | 6.4 |
| 0713 251 04A | DC Solar PV Systems Installation | 64 | 6.4 |
| 0713 251 05 A | Solar Water Pump System Installation | 62 | 6.2 |
| **MODULE TWO** | | | |
| 0713 351 07A | Electrical installation | 140 | 14.0 |
| 0713 351 08A | Solar PV systems | 140 | 14.0 |
| 0713 351 09A | Solar water pump system | 120 | 12.0 |

**MODULE THREE**

|  |  |  |  |
| --- | --- | --- | --- |
| **BASIC UNITS** | | | |
| **Unit Code** | **Units Title** | **Unit Duration (Hours)** | **Credit Factor** |
| 0611 451 02A | Digital literacy | 80 | 8.0 |
| 0031 441 01A | Communication skills | 40 | 4.0 |
| 0413 441 03A | Entrepreneurial skills | 60 | 6.0 |
| **COMMON UNITS OF COMPETENCY** | | | |
| **Unit Code** | **Units Title** | **Unit Duration (Hours)** | **Credit Factor** |
| 0541 441 05A | Engineering technician mathematics I | 100 | 10.0 |
| 0713 441 06A | Electrical principles I | 50 | 5.0 |
| 0714 541 13A | Digital Electronics I | 60 | 6.0 |
| 0714 541 12A | Analogue Electronics I | 50 | 5.0 |
| CORE UNITS OF COMPETENCY | | | |
| **Unit Code** | **Units Title** | **Unit Duration (Hours)** | **Credit Factor** |
| 0713 451 10A | Electrical installation I | 50 | 5.0 |
| 0713 451 11A | Solar PV Systems Design | 70 | 7.0 |

|  |  |  |  |
| --- | --- | --- | --- |
| **MODULE FOUR** | | | |
| **BASIC UNITS** | | | |
| **Unit Code** | **Units Title** | **Unit Duration (Hours)** | **Credit Factor** |
| 0413 441 04A | Entrepreneurial skills | 60 | 6.0 |
| **COMMON UNITS OF COMPETENCY** | | | |
| **Unit Code** | **Units Title** | **Unit Duration (Hours)** | **Credit Factor** |
| 0541 441 05A | Engineering technician mathematics II | 80 | 8.0 |
| 0713 441 06A | Electrical principles II | 70 | 7.0 |
| 0732 441 08A | Technical drawings | 120 | 12.0 |
| 0714 541 13A | Digital Electronics 2 | 70 | 7.0 |
| 0714 541 12A | Analogue Electronics 2 | 50 | 5.0 |
| CORE UNITS OF COMPETENCY | | | |
| **Unit Code** | **Units Title** | **Unit Duration (Hours)** | **Credit Factor** |
| 0713 451 10A | Electrical installation II | 70 | 7.0 |
| 0713 451 13A | Solar PV Pumps System Installation | 80 | 8.0 |
| 0713 451 14A | Security systems installation | 70 | 7.0 |
| **Industrial Attachment** | | 480 | 48.0 |
| **GRAND TOTAL** | | **2300** | **230.0** |

The total duration of the **course is 2300 hours** (77 weeks at 30 hours per week) inclusive of industrial attachment.

## Industrial attachment

An individual enrolled in this course will be required to undergo an industrial attachment in an Electrical or Solar firm for a period of at least 480 hours.

## Entry Requirements

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

1. Kenya Certificate of Primary Education (KCPE)

**Or**

1. Equivalent qualifications as determined by TVETA

**Trainer Qualification**

Qualifications of a trainer for this course include:

1. Possession of at least Solar PV System level 5 or in related trade area;
2. License by TVETA; and
3. License by EBK/KETRB

**Industry Training**

An individual enrolled in this course will be required to undergo Industry training for a minimum period of 480 hours in solar PV 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**

The course shall be assessed formatively and summatively:

1. During formative assessment all performance criteria shall be assessed based on performance criteria weighting.
2. Number of formative assessments shall minimally be equal to the number of elements in a unit of competency.
3. For qualification packs that commence at levels 3 or 4, assessments of modules 1 and 2 shall be in accordance with assessment guidelines for levels 3 and 4.
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:
6. 10 :90 for units in module 1 and module 2
7. 30:70 for units in module 3 to module 5
8. Formative and summative assessments shall be weighted at 60% and 40% respectively in the overall unit of learning score
9. For a candidate to be declared competent in a unit of competency, the candidate must meet the following conditions:
10. Obtained at least 40% in theory assessment in formative and summative assessments.
11. Obtained at least 60% in practical assessment in formative and summative assessment where applicable.
12. 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.
13. 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 issued with a Certificate of Competency upon demonstration of competence in a core Unit of Competency. To attain the Kenya National TVET Certificate in Solar PV System Installation Technology Level 5, the candidate must demonstrate competence in all the Units of Competency as given in the qualification pack. Statement of Attainment certificate may be awarded upon demonstration of competence in certifiable element within a unit.

These certificates will be issued by ……… (QAI)

# MODULE ONE

**ELECTRICAL INSTALLATION**

**UNIT CODE: 0713 251 01A**

**UNIT DURATION: 70 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: performing electrical installation

**Unit Description**

This unit specifies competences required for performing electrical installation. The competences include identifying electrical installation components, installing electrical system and maintaining electrical installation.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Identify electrical installation components | **20** |
|  | Install electrical system | **40** |
|  | Maintain electrical installation | **10** |
|  | **TOTAL** | **70** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify electrical installation components | * 1. Electrical symbols   2. Electrical Materials   3. Electrical routes | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 1. Install electrical system | * 1. Safety measures      1. PPE      2. Electrical hazards   2. Tools and equipment      1. Fixing tools      2. Cutting tools      3. Measuring tools e.g. Tape measure, Tri-square, Steel rule, Spirit level      4. Holding tools      5. Power tools      6. Multimeter   3. Materials      1. Cables      2. Lighting Accessories      3. Power accessories   4. Cable management system      1. Sheath/surface      2. PVC Conduits      3. Mini-Trunking   5. Protection devices      1. Circuit breakers      2. Fuses   6. Electrical circuits      1. Lighting circuit      2. Ring and radial circuits   7. Testing      1. Continuity      2. Polarity   8. Housekeeping practice      1. Waste disposal      2. Recycle      3. Reuse      4. Reduce | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 3. Maintain electrical installation | * 1. Electrical equipment and system Inspection   2. Materials and tools assembly   3. Maintenance   4. Maintenance reports | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |

**Suggested Methods of Instruction**

Practical

Projects

Demonstrations

Group discussion

Direct instructions

Field trips

On-job-training

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | * B. Scaddan Electrical installation work * J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | * IEEE regulation * BS3939 * NEMA regulations * OSHA * Occupational Safety and Health Act (OSHA) * National Environmental Management Authority (NEMA) regulations * IEEE regulations * EPRA regulation | 5 pcs | 1:5 |
|  | Charts | * Single line diagram * Circuit diagrams * Colour codes | 1 pcs for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical cables | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Conduits and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Earth resistance meter |  | 5 pcs | 1:5 |
|  | Steel conduit bending machine |  | 2 pcs | 1:13 |
|  | Stocks & Dies |  | 5 pcs | 1:5 |
|  | Vices |  | 5 pcs | 1:5 |
|  | Bending spring |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Crocodile clips |  | 50 pcs | 2:1 |
|  | Mc4 clips |  | 50 pcs | 2:1 |
|  | Clamp clips |  | 50 pcs | 2:1 |
|  | Cable ties |  | 1250 pcs | 50:1 |
|  | Bolt and nuts |  | 150 pcs | 6:1 |
|  | Wall plug |  | 150 pcs | 6:1 |
|  | Work stations |  | 25 | 1:1 |
|  | Installation boards | 1.2 by 1m | 13 pcs | 1:2 |

## DC SOLAR PV SYSTEMS

**UNIT CODE: 0713 251 04A**

**UNIT DURATION: 70 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: install DC solar PV systems

**Unit Description**

This unit covers competences required in installing solar PV systems. The competences include constructing DC solar PV support structures, installing DC solar PV system components and maintaining DC solar PV system

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Construct DC Solar PV support structures | **10** |
|  | Install DC Solar PV system components | **42** |
|  | Maintain DC Solar PV System | **10** |
|  | **TOTAL** | **62** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Construct DC Solar PV support structures | * 1. Safety procedures   2. Types of mounting structures      1. Solar roof system      2. Steel ground racks      3. Pole mounting   3. Solar PV batteries structures | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 2. Install DC Solar PV system components | * 1. Solar PV module      1. Mono crystalline      2. Poly crystalline      3. Amorphous      4. Single module up to 300 Wp.   2. Components of solar system mounting and installation      1. Charger controller      2. Solar batteries      3. Cables   3. Solar PV batteries      1. Maintenance free      2. Flooded type      3. Single battery 12V   4. Lay Electrical cables   5. Lightening arrestors installation      1. Earth Rod      2. Surge arrestor (SPD)   6. Housekeeping practice      1. Waste disposal      2. Recycle      3. Reuse      4. Reduce | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 3. Maintain solar PV system | * 1. Maintenance materials preparation   2. Maintenance      1. Cleaning the modules      2. Cleaning battery terminals      3. Applying jelly/grease on battery terminals      4. Checking states of electrolytes   3. Maintenance reports | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |

**Suggested Methods of Instruction**

Practical

Projects

Demonstrations

Group discussion

Direct instructions

Field trips

On-job-training

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | * B. Scaddan Electrical installation work * J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | * IEEE regulation * BS3939 * NEMA regulations * OSHA * Occupational Safety and Health Act (OSHA) * National Environmental Management Authority (NEMA) regulations * IEEE regulations * EPRA regulation | 5 pcs | 1:5 |
|  | Charts | * Single line diagram * Circuit diagrams * Colour codes | 1 pcs for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical cables | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Conduits and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Earth resistance meter |  | 5 pcs | 1:5 |
|  | Steel conduit bending machine |  | 2 pcs | 1:13 |
|  | Stocks & Dies |  | 5 pcs | 1:5 |
|  | Vices |  | 5 pcs | 1:5 |
|  | Bending spring |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Crocodile clips |  | 50 pcs | 2:1 |
|  | Mc4 clips |  | 50 pcs | 2:1 |
|  | Clamp clips |  | 50 pcs | 2:1 |
|  | Cable ties |  | 1250 pcs | 50:1 |
|  | Bolt and nuts |  | 150 pcs | 6:1 |
|  | Wall plug |  | 150 pcs | 6:1 |
|  | Work stations |  | 25 | 1:1 |
|  | Installation boards | 1.2 by 1m | 13 pcs | 1:2 |

**SOLAR WATER PUMP SYSTEM INSTALLATION**

**UNIT CODE: 0713 251 05A**

**UNIT DURATION: 62 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: install solar PV water pump systems

**Unit Description**

This unit covers competences required in install solar water pump system. The competences include constructing solar PV module system support structures, installing solar water pump system components and maintaining solar water pump system.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Construct Solar PV module system support structures | **10** |
|  | Install Solar PV water pump system components | **42** |
|  | Maintain solar PV water pump system | **10** |
|  | **TOTAL** | **62** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Construct Solar PV water pump system support structures | * 1. Safety procedures   2. Types of solar PV mounting structures  1. Solar roof system 2. Steel ground racks 3. Pole mounting    1. Solar PV water pump mounting structures design interpretation. | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 2. Install Solar water pump system component | * 1. Solar PV module mounting      1. Mono crystalline      2. Poly crystalline      3. Amorphous   2. Single panel up to 300 Wp   3. Solar PV water pump installation      1. Surface/submersible DC water pump   4. Cables joints   5. Lightening arrestor   6. Housekeeping practice      1. Waste disposal      2. Recycle      3. Reuse      4. Reduce | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |
| 3. Maintain solar water pump system | * 1. Solar water pump Materials preparation      1. Cables      2. Cable ties      3. Accessories      4. Grease   2. Solar PV water pump system testing   3. Maintenance activities      1. Cleaning module      2. Removal of silt   4. Maintenance report preparation | * Project * practical * Portfolio of evidence * Third party report * Written assessment * Oral assessment |

**Suggested Methods of Instruction**

Practical

Projects

Demonstrations

Group discussion

Direct instructions

Field trips

On-job-training

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | * B. Scaddan Electrical installation work * J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | * IEEE regulations * BS3939 * NEMA regulations * Occupational Safety and Health Act (OSHA) * National Environmental Management Authority (NEMA) regulations * EPRA regulation * PV system requirement refer KEBS Standards of 1673-1:2004 | 5 pcs | 1:5 |
|  | Charts | * Single line diagram * Circuit diagrams * Colour codes | 1 pcs for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical wires | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Conduits and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Inclinometer |  | 5 pcs | 1:5 |
|  | Spanner |  | 5 pcs | 1:5 |
|  | cable lugs |  | 150 pcs | 6:1 |
|  | racks |  | 13 | 1:2 |
|  | solar spacer |  | 25 | 1:1 |
|  | mounting spacer |  | 25 | 1:1 |
|  | ground mount pipe caps |  | 50 pcs | 2:1 |
|  | solar panel cleaning kit |  | 13 | 1:2 |
|  | Locking tool clip |  | 13 | 1:2 |
|  | Permanent roof anchor |  | 13 | 1:2 |
|  | Mounting brackets |  | 13 | 1:2 |
|  | Crocodile clips |  | 50 pcs | 2:1 |
|  | Mc4 clips |  | 50 pcs | 2:1 |
|  | MC4 Climping tool |  | 5 pcs | 1:5 |
|  | Clamp clips |  | 50 pcs | 2:1 |
|  | Cable ties |  | 1250 pcs | 50:1 |
|  | Bolt and nuts |  | 150 pcs | 6:1 |
|  | Wall plug |  | 150 pcs | 6:1 |
|  | Ladder |  | 5 | 1:5 |
|  | Module mover |  | 5 | 1:5 |
|  | ballast block carrier |  | 5 | 1:5 |
|  | Thermal camera |  | 5 | 1:5 |
|  | Irradiance meter |  | 5 | 1:5 |
|  | Insulation resistance tester |  | 5 | 1:5 |
|  | Vent pipe cutter |  | 5 | 1:5 |
|  | Work stations |  | 25 | 1:1 |
|  | Installation boards | 1.2 by 1m | 13 pcs | 1:2 |

# MODULE TWO

## ELECTRICAL INSTALLATION

**UNIT CODE: 0713 351 04A**

**UNIT DURATION: 140 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform electrical installation

**Unit Description**

This unit specifies competences required for performing electrical installation. The competences include producing electrical drawings, interpreting electrical installation drawing, installing electrical system, testing electrical installation and maintaining electrical installation.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Produce electrical drawings | **10** |
|  | Interpret electrical installation drawing | **30** |
|  | Install electrical system | **60** |
|  | Test electrical installation | **20** |
|  | Maintain electrical installation | **20** |
|  | **TOTAL** | **140** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Produce electrical drawings | * 1. Electrical symbols and abbreviations   2. Meaning of electrical drawings   3. Drawing of electrical diagrams e.g. block, schematic, circuit, line and wiring | * Practical demonstration * Projects * Written tests * Oral test |
| 1. Interpret electrical installation drawing | * 1. Wiring diagrams      1. Single line diagram         1. Intake point         2. Lighting plan         3. Power circuit   2.1.1.4 Change over switching   * + 1. Schematic diagram     2. Wiring diagram   1. Bill of quantities; | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |
| 1. Install electrical system | * 1. Safety; PPE, handling of equipment   2. Tools, equipment and materials   3.2.1 Cutting tools e.g. Hacksaws, Stripping knives, Side cutters, Pliers   * + 1. Fixing tools e.g. Assorted hammers, Assorted Screw drivers     2. Fastening tools e.g Assorted spanners and wrenches     3. Lifting and tensioning tools     4. Holding tools     5. Power tools     6. Multimeter     7. Cables     8. Accessories   1. Cable management systems      1. Cable duct      2. Steel Conduits      3. Trunking   2. Cable Termination techniques      1. Cable lugs      2. Cable glands      3. Cable joints i.e Tee joint, married joint, end twist, Britannia joint.   3. Earthing and protection systems      1. IT      2. TNC      3. TNS      4. TT      5. TNCS/PME/PEN/CNE      6. Circuit breakers      7. Fuses      8. ELCBs/RCD   4. Installation of final circuits      1. ***Special*** Lighting circuits      2. Power circuits   5. Housekeeping practices      1. Disposal of waste      2. Reusing      3. Recycling      4. Cleaning and storage of tools and equipment | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |
| 1. Test electrical installation | * 1. Definition of terms: inspection      1. Visual inspection:         1. Colour codes         2. Labelling         3. Damages         4. Termination   2. Electrical tests      1. Continuity test      2. Insulation resistance test      3. Polarity test   3. IEE Regulations | * Practical * Demonstration * Projects * Written tests * Oral Questioning |
| 1. Maintain electrical installation | * 1. Definition; maintenance; servicing; repair; fault, diagnosis/troubleshooting   2. Visual inspection:      1. Colour codes      2. Labelling      3. Damages      4. Termination   3. Importance of maintenance   4. Maintenance materials and tools      1. Hacksaws      2. Stripping knives      3. Side cutters      4. Pliers      5. Tape measure      6. Assorted hammers      7. Assorted Screw drivers      8. Assorted spanners and wrenches      9. Digital Multimeter      10. Phase tester   5. Cause of equipment failure   6. Maintenance activities      1. Faulty lamps      2. Faulty accessories      3. Types of Maintenance         1. Preventive Maintenance         2. Corrective Maintenance         3. Predictive Maintenance         4. Condition-Based Maintenance   7. Types of faults      1. Short circuits      2. Loose connections      3. Bad connections      4. Open circuits   8. Electrical tests      1. Continuity test      2. Insulation resistance test      3. Polarity test   9. Maintenance report      1. Repairs      2. Inspection      3. Maintenance task e.g preventive maintenance task      4. Test and maintenance report form | * Practical * Demonstration * Projects * Written tests * Oral Questioning |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions
6. Field trips
7. On-job-training

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | B. Scaddan Electrical installation work  J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | IEEE regulation  BS3939  NEMA regulations  OSHA | 5 pcs | 1:5 |
|  | Charts | Single line diagram  Circuit diagrams  Colour codes | 1 pcs for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Laboratory | 100m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical wires | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Pipes and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Clamp meters |  | 5 pcs | 1:5 |
|  | Insulation resistance meter |  | 5 pcs | 1:5 |
|  | Earth resistance meter |  | 5 pcs | 1:5 |
|  | Stocks & Dies |  | 5 pcs | 1:5 |
|  | Vices |  | 5 pcs | 1:5 |
|  | Oscilloscope |  | 5 pcs | 1:5 |
|  | Pipe bending Machine |  | 5 pcs | 1:5 |
|  | Bending spring |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |
|  | Installation boards | 1.2 by 1m | 13 pcs | 1:2 |

## SOLAR PV SYSTEMS INSTALLATION

**UNIT CODE: 0713 351 08A**

**UNIT DURATION: 140 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: install solar PV systems

**Unit Description**

This unit covers the competences required in Install Solar PV Systems. Competences include; applying electrical concepts, constructing Solar PV support structures, installing Solar PV system components and maintaining solar PV system.

**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 basic electrical concepts | **20** |
|  | Construct Solar PV support structures | **40** |
|  | Install Solar PV system component | **60** |
|  | Maintain solar PV system | **20** |
|  | **TOTAL** | **140** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply basic electrical concepts | * 1. The meaning of SI unit   2. SI unit of various types of Electrical parameters      1. Power – Watts (W)      2. Current – Amperes (A)      3. Resistance – Ohms(Ω)      4. Voltage – Volts (V)   3. Identification of Quantities of Charge, force, work and power   4. Ohm’s law   5. Calculations involving parallel and series circuits   6. Calculations involving various Electrical parameters e.g. Power, Current, Voltage, Resistance | * Practical demonstration * Projects * Written tests   Oral test |
| 1. Construct Solar PV support structures | * 1. Safety Procedures   2. Tools and equipment      1. Hydrometer      2. Inclinometer      3. Compass   3. Types of mounting structures      1. Rooftop      2. Ground      3. Solar roof system      4. Steel ground racks      5. Pole mounting   4. Solar PV Battery structures | * Practical * demonstration * Projects * Written tests * Oral Questioning |
| 1. Install Solar PV system components | * 1. Planning to install   2. Pre-installation checks   3. Solar Panel Mounting positioning   4. security of the panels   5. Methods of solar panel connection      1. Parallel and series   6. Components of solar system mounting and installation      1. Charger controller      2. Inverters      3. Solar batteries e.g Maintenance free, Flooded type, Series connection up to 24v/1000wp, Parallel connection up to 24v/1000wp, Series-parallel connection up to 24v/1000wp   7. Cables   8. Lay Electrical cables      1. Cable laying tools      2. Cable segregation      3. Cable labelling   9. Mount Solar panel      1. Installation of Solar panel         1. Slanting angle/tilt angle         2. Panel Ratings   10. Terminate solar Electrical cables       1. Meaning of terms       2. Cable lugging       3. Solar Cable connectors   11. Lightening arrestors base installation       1. Rod gap arrester       2. Earth Rod       3. Surge arrestor (SPD)   12. Housekeeping       1. Waste disposal       2. Recycle       3. Reuse       4. Reduce | * Practical * demonstration * Projects * Written tests * Oral Questioning |
| 1. Maintain solar PV system | * 1. Materials e.g pure water, soft bristle brushes, microfiber cloths or sponges, calcium, grease   2. Tests      1. Continuity test      2. Insulation resistance test      3. Polarity test      4. Short circuit systems (Isc)      5. Open circuit voltage (Voc)      6. Battery voltage and current   3. Maintenance of;      1. Solar modules      2. Solar batteries maintenance      3. Inverter maintenance      4. Charge controller maintenance   4. Maintenance records      1. Maintenance checklist      2. Maintenance reports | * Practical * demonstration * Projects * Written tests * Oral Questioning |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions
6. Field trips
7. On-job-training

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Solar Electric Handbook by Solar energy International  B. Scaddan Electrical installation work  J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | Solar PV manuals | 5 pcs | 1:5 |
|  | Charts | Single line diagram  Solar PV layout  Circuit diagrams  Colour codes | 1 pc for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Laboratory | 100m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical wires | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Solar Panels |  | 10 | 1:3 |
|  | Charge controller |  | 10 | 1:3 |
|  | Batteries |  | 10 | 1:3 |
|  | Inverter |  | 10 | 1:3 |
|  | Mounting racks |  | 10 | 1:3 |
|  | Pipes and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
|  | Materials and supplies | Clamp clips,Cable ties, Conduits, Bolt and nuts, Wall plug, Mounting brackets, cable lugs, racks, solar spacer, mounting spacer, ground mount pipe caps, cleaning kit, Locking tool clip, Permanent roof anchor | 10 | 1:3 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | MC4 Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Irradiance meter |  | 5 pcs | 1:5 |
|  | Insulation resistance tester |  | 5 pcs | 1:5 |
|  | Polarity tester |  | 5 pcs | 1:5 |
|  | Clamp meter |  | 5 pcs | 1:5 |
|  | Thermal camera |  | 5 pcs | 1:5 |
|  | Inclinometer |  | 5 pcs | 1:5 |
|  | Ladder |  | 5 pcs | 1:5 |
|  | ballast block carrier |  | 5 pcs | 1:5 |
|  | Module mover |  | 5 pcs | 1:5 |
|  | Vent pipe cutter |  | 5 pcs | 1:5 |
|  | Flat pry bar |  | 5 pcs | 1:5 |
|  | Battery operated drill |  | 5 pcs | 1:5 |
|  | Safety harness |  | 25 pcs | 1:1 |

## SOLAR WATER PUMP SYSTEM INSTALLATION

**UNIT CODE: 0713 351 09A**

**UNIT DURATION: 120 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: install solar water pump systems

**Unit Description**

This unit covers the competences required in Install Solar Water Pump System. Competences include; managing electrical workshop, constructing Solar PV module system support structures, installing Solar water pump system components, maintaining solar water pump system.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Manage electrical workshop | **10** |
|  | Construct Solar PV module system support structures | **40** |
|  | Install Solar water pump system components | **60** |
|  | Maintain solar water pump system | **10** |
|  | **TOTAL** | **120** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Manage electrical workshop | 1.1. Health and safety procedures   * + 1. Safety measures.     2. Relevant clauses in appropriate Acts e.g.     3. Occupational safety and health act (OSHA)     4. Work injury benefits act (WIBA)     5. Safety Regulations and procedures     6. PPEs     7. First Aid     8. Relevant regulations e.g. IEE regulations     9. Common hazards and sources of danger e.g. burns, cuts, electric shock, falling from heights, falling objects, noise, dust, chemicals   1. Electrical workshop records e.g.      1. Inventory      2. Duty schedule      3. Maintenance schedule, etc.   2. Storage of Tools, equipment and materials | * Practical demonstration * Projects * Written tests * Oral test |
| 1. Construct Solar PV module system support structures | * 1. Solar PV modules e.g Mono crystalline, Poly crystalline, Amorphous      1. Solar PV connections e.g Series connection up to 1000 wp      2. Parallel connection up to 1000 wp      3. Series-parallel connection up to 1000 wp   2. Types of mounting structures      1. Rooftop      2. Ground      3. Solar roof system      4. Steel ground racks      5. Pole mounting   3. Solar PV water pump mounting structures e.g ground mount systems, top of pull mount, scalable ground mount | * Practical * demonstration * Projects * Written tests * Oral Questioning |
| 1. Install Solar PV pump system components | * 1. Solar PV module mounting      1. Flat roof mounting      2. roof hook      3. Water proof carport      4. Packing canopy      5. Ground mounting   2. Solar pumping system      1. Module      2. PV pump inverter      3. Pumps and motors; ac and dc   3. Types of single-phase pump systems      1. Submersible pump      2. Floating pumps      3. Surface pumps   4. Lightening arrestor; components of lightening arrestors, importance of lightening arrestors   5. Housekeeping      1. Waste disposal      2. Recycle      3. Reuse      4. Reduce | * Practical * demonstration * Projects * Written tests * Oral Questioning |
| 1. Maintain solar water pump system | * 1. Tests      1. Continuity test      2. Insulation resistance test      3. Polarity test      4. Short circuit systems (Isc)      5. Open circuit voltage (Voc)      6. Irradiance meter   2. Maintenance is carried out as per IET regulations   3. Maintenance records      1. Maintenance checklist      2. Maintenance reports | * Practical demonstration * Projects * Written tests * Oral Questioning |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions
6. Field trips
7. On-job-training

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Solar Electric Handbook by Solar energy International  B. Scaddan Electrical installation work  J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | Solar PV manuals | 5 pcs | 1:5 |
|  | Charts | Single line diagram  Solar PV layout  Circuit diagrams  Colour codes | 1 pc for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Laboratory | 100m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical wires | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Solar Panels |  | 10 | 1:3 |
|  | Charge controller |  | 10 | 1:3 |
|  | Batteries |  | 10 | 1:3 |
|  | Inverter |  | 10 | 1:3 |
|  | Mounting racks |  | 10 | 1:3 |
|  | Pipes and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
|  | Materials and supplies | Clamp clips,Cable ties, Conduits, Bolt and nuts, Wall plug, Mounting brackets, cable lugs, racks, solar spacer, mounting spacer, ground mount pipe caps, cleaning kit, Locking tool clip, Permanent roof anchor | 10 | 1:3 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | MC4 Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Irradiance meter |  | 5 pcs | 1:5 |
|  | Insulation resistance tester |  | 5 pcs | 1:5 |
|  | Polarity tester |  | 5 pcs | 1:5 |
|  | Clamp meter |  | 5 pcs | 1:5 |
|  | Thermal camera |  | 5 pcs | 1:5 |
|  | Inclinometer |  | 5 pcs | 1:5 |
|  | Ladder |  | 5 pcs | 1:5 |
|  | ballast block carrier |  | 5 pcs | 1:5 |
|  | Module mover |  | 5 pcs | 1:5 |
|  | Vent pipe cutter |  | 5 pcs | 1:5 |
|  | Flat pry bar |  | 5 pcs | 1:5 |
|  | Battery operated drill |  | 5 pcs | 1:5 |
|  | Safety harness |  | 25 pcs | 1:1 |

# 

# MODULE THREE

# BASIC UNITS OF COMPETENCY

## DIGITAL SKILLS

**UNIT CODE: 0611 451 02B**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Digital Literacy

**Duration of Unit:** 40 Hours

**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 performing jobs online.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Operate Computer Devices | **10** |
|  | Solve Tasks Using Office Suite | **5** |
|  | Manage Data and Information | **10** |
|  | Perform Online Communication and Collaboration | **5** |
|  | Apply Cyber security Skills | **5** |
|  | Perform Online Jobs | **5** |
| **TOTAL** | | **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   6. The System Unit E.g. Motherboard, CPU, casing   7. Input Devices e.g. Pointing, keying, scanning, voice/speech recognition, direct data capture devices.   8. Output Devices e.g. hardcopy output and softcopy output   9. Storage Devices e.g. main memory e.g. RAM, secondary storage (Solid state devices, Hard Drives, CDs & DVDs, Memory cards, Flash drives   10. Computer Ports e.g. HDMI, DVI, VGA, USB type C etc.   11. Classification of computer software   12. Operating system functions   13. Procedure for turning/off a computer   14. Mouse use techniques   15. Keyboard Parts and Use Techniques   16. Desktop Customization   17. File and Files Management using an operating system   18. Computer Internet Connection Options       1. Mobile Networks/Data Plans       2. Wireless Hotspots       3. Cabled (Ethernet/Fiber)       4. Dial-Up       5. Satellite       6. Computer external devices management   19. Device connections   20. Device controls (volume controls and display properties) | 1. Observation 2. Portfolio of Evidence 3. Project 4. Written assessment 5. Practical assessment 6. Oral 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 presentation       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       + Spell check a presentation       + Slide orientation       + Slide shows, navigation   26. Print presentations (slides and handouts) | 1. Observation 2. Portfolio of Evidence 3. Project 4. Written assessment 5. Practical assessment 6. 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 | 1. Observation 2. Portfolio of Evidence 3. Project 4. Written assessment 5. Practical assessment 6. 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 | 1. Observation 2. Portfolio of Evidence 3. Project 4. Written assessment 5. Practical assessment 6. Oral assessment |
| 1. Apply cyber security 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 | 1. Observation 2. Portfolio of Evidence 3. Project 4. Written assessment 5. Practical assessment 6. Oral assessment |
| 1. Perform Online Jobs | * 1. Introduction to online working   2. Types of online Jobs   3. Online job platforms      1. Remotask      2. Data annotation tech      3. Cloud worker      4. Upwork      5. Oneforma      6. Appen   4. Online account and profile management   5. Identifying online jobs/job bidding   6. Online digital identity   7. Executing online tasks   8. Management of online payment accounts. | 1. Observation 2. Portfolio of Evidence 3. Project 4. Written assessment 5. Practical assessment 6. Oral assessment |
| 1. Apply job entry techniques | * 1. Types of job opportunities      1. Self-employment      2. Service provision      3. product development      4. salaried employment   2. Sources of job opportunities   3. Resume/ curriculum vitae      1. What is a CV      2. How long should a CV be      3. What to include in a AC      4. Format of CV      5. How to write a good CV      6. Don’ts of writing a CV   4. Job application letter      1. What to include      2. Addressing a cover letter      3. Signing off a cover letter   5. Portfolio of Evidence      1. Academic credentials      2. Letters of commendations      3. Certification of participations      4. Awards and decorations   6. Interview skills      1. Listening skills      2. Grooming      3. Language command      4. Articulation of issues      5. Body language      6. Time management      7. Honesty   7. Generally knowledgeable in current affairs and technical area | 1. Observation 2. Portfolio of Evidence 3. Project 4. Written assessment 5. Practical assessment 6. Oral 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 25 Trainees**

|  |  |  |
| --- | --- | --- |
| **S/N0** | **RESOURCES** | **QUANTITY** |
|  | computers with the following software:   * **Windows/Linux/Macintosh Operating System** * **Microsoft Office Software** * **Google Workspace Account** * **Antivirus Software** | **25** |
|  | Printers | **2** |
|  | Printing Papers | **enough** |
|  | External storage media | **25** |
|  | Projector | **1** |
|  | Whiteboard | **1** |
|  | Smartboard/Smart TV (Where applicable) | **1** |
|  | Assorted whiteboard markers | **enough** |
|  | Internet connection | **enough** |
|  | 5 samples of CVs | **5** |
|  | Assorted whiteboard markers | **enough** |
|  | 5 samples of job applications | **5** |

## COMMUNICATION SKILLS

**UNIT CODE:0031 441 01B**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Communication Skills

**Duration of Unit:** 40 hours

**Unit Description**

This unit covers the competencies required to apply communication skills. It involves applying communication channels, written communication skills, non-verbal skills, oral communication skills, 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 Outcome** | **Duration (Hours)** |
|  | Apply communication channels. | **10** |
|  | Apply written communication skills. | **10** |
|  | Apply non-verbal skills. | **10** |
|  | Apply oral communication skills. | **5** |
|  | Apply group communication skills. | **5** |
| **TOTAL** | | **40** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply communication channels | * 1. Communication process   2. Principles of effective communication   3. Channels/medium/modes of communication   4. Factors to consider when selecting a channel of communication   5. Barriers to effective communication   6. Flow/patterns of communication   7. Sources of information   8. Organizational policies | 1. Oral questions 2. Written assessment 3. Observation 4. Portfolio of Evidence 5. Practical assessment 6. Third party report |
| 1. Apply written communication skills | * 1. Types of written communication   2. Elements of communication   3. Organization requirements for written communication | 1. Oral assessment 2. Written assessment 3. Observation 4. Portfolio of Evidence 5. Practical assessment 6. Third party report |
| 1. Apply non-verbal communication skills | 3.1 Utilize body language and gesture  3.2 Apply body posture  3.3 Apply workplace dressing code | 1. Oral assessment 2. Written assessment 3. Observation 4. Portfolio of Evidence 5. Practical assessment 6. Third party report |
| 1. Apply oral communication skills | * 1. Types of oral communication pathways   2. Effective questioning techniques   3. Workplace etiquette   4. Active listening | 1. Oral assessment 2. Written assessment 3. Observation 4. Portfolio of Evidence 5. Practical assessment 6. Third party report |
| 1. Apply group discussion skills | * 1. Establishing rapport   2. Facilitating resolution of issues   3. Developing action plans   4. Group organization techniques   5. Turn-taking techniques   6. Conflict resolution techniques   7. Team-work | 1. Oral assessment 2. Written assessment 3. Observation 4. Portfolio of Evidence 5. Practical assessment |

**Suggested Methods of Instruction**

1. Discussion
2. Roleplaying
3. Simulation
4. Direct instruction
5. Demonstration
6. Field trips

**Recommended Resources for 25 trainees**

|  |  |  |
| --- | --- | --- |
| **General Resources** | **Tools and Equipment** | **Materials and Supplies** |
| 1. 25 Desktop computers/laptops | Mobile phones | Flashcards |
| 1. Internet connection |  | Flip charts |
| 1. 1 Projector 2. 1 Printer |  | 2 packets of assorted colors of whiteboard marker pens |
| 1. 1 Whiteboard |  | Printing papers |
| 1. Report writing templates |  |  |

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# COMMON UNITS OF COMPETENCY

## ENGINEERING TECHNICIAN MATHEMATICS I

**UNIT CODE: 0541 441 05A**

**UNIT DURATION: 80 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply engineering technician mathematics

**Unit Description**

This unit describes the competencies required to apply a wide range of engineering technician mathematics. Competencies include: applying number systems, applying algebra, applying trigonometry and hyperbolic functions, performing coordinates geometry and carrying out binomial expansions.

**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 number systems | **5** |
|  | Apply algebra | **20** |
|  | Apply Trigonometry and Hyperbolic functions | **20** |
|  | Perform coordinates geometry | **15** |
|  | Carry out binomial expansions | **20** |
| **TOTAL** | | **80** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply number systems | * 1. Types of numbers      1. Rounding off numbers to the nearest tens,      2. hundreds, thousands, millions and billions      3. Whole numbers      4. Odd numbers      5. Even numbers      6. Prime number      7. Ratio and proportions   2. Percentages      1. Word problems involving natural      2. Numbers   3. Factors      1. Factors of composite numbers      2. Prime factors      3. Factors in power form   4. Divisibility Test      1. GCD      2. Application of GCD/HCF to real life situations   5. LCM      1. Multiples of a number      2. LCM of a set of numbers      3. Application of LCM in real life situations   6. Integers      1. The number line      2. Operation on integers      3. Order of operations      4. Application to real life situation   7. Fractions      1. Proper, improper fractions and mixed numbers      2. Conversion of improper fractions to mixed numbers and vice versa      3. Comparing fractions      4. Operations on fractions      5. Order of operations on fractions      6. Word problems involving fractions in real life situations   8. Decimals      1. Fractions and decimals      2. Recurring decimals      3. Recurring decimals and fractions      4. Decimal places      5. Standard form      6. Operations on decimals      7. Order of operations      8. Real life problems involving decimals   9. Arithmetic operation      1. Addition      2. Subtraction      3. Multiplication      4. Division   10. Squares and square roots       1. Squares by multiplication       2. Square roots by factorization       3. Squares and Square roots using Calculators | * Written assessment * Practical assessment * Oral Questioning |
| 2. Apply algebra | * 1. Indices and logarithms      1. Indices (powers) and base      2. Laws of indices (including positive      3. integers, negative integers and fractional      4. indices)      5. Powers of 10 and common logarithms      6. Common logarithms;      7. characteristics      8. mantissa      9. Logarithm tables      10. Application of common logarithms in      11. multiplication, division and finding      12. roots   2. Algebra      1. Algebraic expressions including algebraic fractions      2. Simplification of algebraic expressions      3. Factorization by grouping      4. Removal of brackets      5. Substitution and evaluation      6. Problem solving in real situation   3. Simultaneous Equation   4. Solve simultaneous equation by;      1. Elimination method      2. Substitution method      3. Graphical method      4. Solve real life problems   5. Quadratic expressions and equations      1. Expansion of algebraic expressions      2. The three quadratic identities      3. Using the three quadratic identities      4. Factorization of quadratic expressions      5. Solutions of quadratic equations by factor method      6. Formation and solution of quadratic equations | * Written assessment * Practical assessment * Oral Questioning |
| 3. Apply trigonometry and hyperbolic functions | * 1. Importance of trigonometry in engineering.   2. Trigonometric Ratios and Functions      1. Definitions of sine, cosine, tangent, cosecant, secant, and cotangent.      2. Unit circle and angle measurement         1. Degrees and radians         2. Graphs of trigonometric functions.   3. Trigonometric Identities      1. Fundamental identities         1. Pythagorean         2. Reciprocal         3. Quotient identities      2. Co-function identities and even-odd properties.      3. Sum and difference formulas, double-angle, and half-angle formulas.   4. Solving Trigonometric Equations      1. Basic Trigonometric Equations         1. Solving equations involving basic trigonometric functions.         2. Using identities to simplify and solve equations.      2. Inverse Trigonometric Functions         1. Definition and properties.         2. Solving equations using inverse trigonometric functions.      3. Applications of Trigonometric Equations         1. Engineering problems involving periodic functions and waveforms.         2. Harmonic motion and oscillations in mechanical systems.   5. Trigonometry in Triangles      1. Right-Angle Triangles         1. Solving for sides and angles using trigonometric ratios.         2. Applications in engineering problems such as inclined planes and forces.      2. Non-Right-Angle Triangles         1. Law of Sines and Law of Cosines.         2. Solving oblique triangles.         3. Applications in engineering fields of structural analysis and navigation.   6. Introduction to Hyperbolic Functions      1. Definitions of hyperbolic sine, cosine, tangent, and their reciprocals.      2. Graphs and properties of hyperbolic functions.   7. Hyperbolic Identities      1. Fundamental identities         1. Pythagorean-like identities      2. Sum and difference formulas, double-angle, and half-angle formulas.   8. Solving Hyperbolic Equations      1. Basic Hyperbolic Equations         1. Solving equations involving basic hyperbolic functions.         2. Using identities to simplify and solve equations.      2. Inverse Hyperbolic Functions         1. Definition and properties.         2. Solving equations using inverse hyperbolic functions.   9. Applications of Hyperbolic Functions in Engineering | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 4. Perform coordinates geometry | * 1. Polar equations      1. Definition of polar coordinates      2. Definition and examples of polar equations.      3. Representing curves using polar equations.   2. Cartesian equation      1. Definition of Cartesian coordinates.      2. Definition of a point in cartesian coordinates      3. Relationship between Cartesian and polar coordinates.      4. Definition and examples of Cartesian equations.      5. Representing lines, circles, parabolas, ellipses, and hyperbolas using Cartesian equations.      6. Conversion Between Polar and Cartesian Equations.   3. Graphs of polar equations      1. Plotting Polar Equations         1. Definition of a point in polar coordinates         2. Steps to graph polar equations.         3. Using symmetry and periodicity in polar graphs.      2. Analyzing Polar Graphs         1. Identifying key features intercepts, maxima, minima      3. Applications in engineering   4. Normal and tangents      1. Tangents to Curves         1. Definition of a tangent line.         2. Finding the slope of a tangent to a curve at a given point.      2. Normals to Curves         1. Definition of a normal line.         2. Finding the equation of a normal to a curve at a given point.      3. Tangents and Normals in Polar Coordinates         1. Techniques for finding tangents and normals to curves defined by polar equations.   5. Loci      1. Introduction to Loci         1. Definition of Locus         2. Understanding the concept of a locus.         3. Importance of loci in engineering.      2. Locus in Relation to a Circle         1. Equations and properties of loci relative to circles.         2. Common loci problems involving circles      3. Applications in Engineering         1. Using loci to solve engineering problems: robotic arm movement         2. Analyzing Loci of Points: tracing the path of a point on a rotating arm         3. Using loci to optimize mechanical systems: designing cams, robotic path planning. | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report  * Portfolio of evidence |
| 5. Carry out binomial expansion | * 1. Basic concepts of binomial theorem      1. Binomial expressions and notation.      2. Factorials and their use in binomial coefficients.      3. Binomial Coefficients         1. Definition and calculation using combinations (nCr).         2. Pascal’s Triangle as a tool for finding binomial coefficients.   2. Binomial Expansion      1. General form of the binomial expansion expression      2. Binomial Expansion of where  * + 1. Special cases        1. When  * + - 1. Negative and fractional binomial expansions using the binomial series   1. Applications of Binomial Expansion      1. Simplifying algebraic expressions using binomial expansion.      2. Solving polynomial equations.   2. Engineering Applications   3. Estimating values in engineering calculations. | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report  * Portfolio of evidence |

**Suggested Methods of Instruction**

1. Practical
2. Demonstrations
3. Group discussion
4. Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Engineering Mathematics by John bird 8th  edition | 5 pcs | 1:5 |
|  | Engineering Mathematics by A.K stround 8th  edition | 5 pcs | 1:5 |
|  | SMP | 25 | 1:1 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50 m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Charts | Manila papers |  |  |
|  | marker pens | Erasable |  |  |
| **D** | **Tools and Equipment** |  |  |  |
|  | Calculators | Scientific | 25 pcs | 1:1 |

**ELECTRICAL PRINCIPLES I**

**UNIT CODE:****0713 441 07A**

**UNIT DURATION: 50 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply electrical principles

**UNIT DESCRIPTION**

This unit describes competences required to apply electrical principles in their work. It involves Applying Electrical quantities, using cells and batteries, applying magnetism and electromagnetism.

**Summary of Learning Outcomes**

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** | | |
|  | Applying Electrical quantities | **10** | | |
|  | Using cells and batteries | **10** | | |
|  | Applying magnetism and electromagnetism | **20** | | |
| **TOTAL** | | | **50** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + - 1. Applying Electrical quantities | * 1. The meaning of SI unit   2. SI unit of various types of Electrical parameters   3. Ohm’s law   4. Calculations involving various Electrical parameters e.g. Power, Current, Voltage, Resistance   5. Instruments used in measuring various types of Electrical parameters | * Practical * Project * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| * + - 1. Using cells and batteries | * 1. Sources of electricity   2. electrolysis and its applications   3. Simple cells   4. Primary and secondary cells   5. Types of cells and batteries      1. Dry cells      2. Leclanché      3. Mercury      4. Lead-acid      5. Alkaline      6. Lithium   6. E.m.f and internal resistance of cells   7. Maintenance of batteries   8. Applications of batteries | * Practical * Project * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| * + - 1. Apply magnetism and electromagnetism concepts | * 1. Magnetic and non-magnetic materials   2. Concepts of magnetic fields and field distribution   3. Concepts of electromagnetism   4. Laws of electromagnetic induction   5. Concepts of self and mutual induction | * Practical * Project * Third party report * Portfolio of evidence * Written tests * Oral questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Field trips
* On-job-training

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | J. Bird Electrical and Electronic Principles  V.K. Mehta & R. Mehta Basic Electrical Engineering | 5 pcs | 1:5 |
|  | Installation manuals | Electronic components datasheets | 5 pcs | 1:5 |
|  | Charts | Circuit diagrams  Colour codes | 1 pcs for each | 1:25 |
|  | Scientific Calculators |  | 25 | 1:1 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Laboratory | 100m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Connector wires | Jumper wires, | 5 pkts | 1:5 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Circuit boards | Bread board, copper strip boards | 25 pcs | 1:1 |
|  | Assorted electronic components | Resistors, diodes, capacitors, transistors, ICs, Transformers, Inductors, Batteries | 25 pcs | 1:1 |
|  | Soldering wires |  | 5 rolls | 1:5 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Oscilloscope |  | 5 pcs | 1:5 |
|  | Function generator |  | 5 pcs | 1:5 |
|  | Spectrum analyser |  | 5 pcs | 1:5 |
|  | Variable power supply |  | 5 pcs | 1:5 |
|  | Solder guns |  | 25 pcs | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |

## TECHNICAL DRAWINGS

**UNIT CODE: 0732 441 08A**

**UNIT DURATION:100 HOURS**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Prepare technical drawings

**UNIT DESCRIPTION**

This unit covers competences required to prepare technical drawings. Competences include preparing drawing equipment and materials, producing plane geometry drawings, Producing pictorial and orthographic drawings of components.

**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 drawing equipment and materials | **20** |
|  | Produce plane geometry drawings | **40** |
|  | Produce pictorial and orthographic drawings of components | **40** |
| **TOTAL** | | **100** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Prepare drawing equipment and materials | * 1. Identification and care of drawing equipment      1. Drawing boards      2. T and set squares      3. Drawing set   2. Identification and care of drawing materials      1. Drawing papers      2. Pencils      3. Erasers      4. Masking tapes      5. Paper clips   3. Reference to manufacturer’s instructions and work place procedures on use and maintenance of drawing equipment and materials | * Practical * Project * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Produce plane geometry drawings | * 1. Types of lines in drawings   2. Freehand printing of letters   3. Borderlines and title blocks   4. Construction of different angles   5. Measurement of different angles   6. Bisection of different angles and lines   7. Construction of geometric figures      1. Circles      2. Triangles      3. Rectangles      4. Parallelogram      5. Polygons      6. Pyramids      7. Conic sections      8. Prisms   8. Patterns development e.g cones, pyramids, prisms, cylinders   9. Different types of Tangents      1. Exterior tangents to a circle      2. Interior tangents to a circle   10. Standard drawing conventions | * Practical * Project * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Produce pictorial and orthographic drawings of components | * 1. Meaning of pictorial and orthographic drawings   2. Meaning of symbols and abbreviations   3. Free hand sketching of different types of geometric forms, tools and equipment   4. Drawing and interpretation of orthographic elevations   5. Drawing objects in isometric view   6. Drawing objects in oblique view | 1. Practical  * Project * Third party report * Portfolio of evidence * Written tests * Oral questioning |

**Suggested Methods of Delivery**

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

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | K.Morling Geometric and Engineering drawing | 5 pcs | 1:5 |
|  | Drawing instruments | T-squares, set squares, drawing sets, Masking tapes | 25 | 1:1 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50m2 | 1 | 1:25 |
|  | Drawing tables |  | 25 | 1:1 |

## DIGITAL ELECTRONICS I

**UNIT CODE: 0714 541 13A**

**UNIT DURATION: 60Hours**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Digital Electronics

**Unit Description**

This unit describes competences required to apply digital electronics. Competences include applying knowledge of number systems, applying knowledge of binary code and applying logic gates and Boolean algebra concepts.

**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 knowledge of number systems | **10** |
|  | Apply knowledge of binary codes | **20** |
|  | Apply Logic gates and Boolean algebra concepts | **30** |
| **TOTAL** | | **60** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply knowledge of number systems | * 1. Numbers systems e.g.      1. Decimal      2. Octal      3. Hexadecimal      4. Binary   2. Number system representation   3. Conversion of number systems   4. Perform 1’s and 2’s complement | 1. Observation 2. Written test 3. Practical 4. Demonstration 5. Oral questioning 6. Third party report |
| 1. Apply knowledge of binary codes | * 1. BCD (Binary Coded Decimal)   2. Gray Code   3. Excess 3 code | 1. Observation 2. Written test 3. Practical 4. Demonstration 5. Oral questioning 6. Third party report |
| 1. Apply Logic gates and Boolean algebra concepts | * 1. Basic logic gates   2. Universal logic gates operation   3. Special purpose gates   4. laws of Boolean algebra   5. Logic expressions simplification   6. K-MAPS | 1. Observation 2. Written test 3. Practical 4. Demonstration 5. Oral questioning 6. Third party report |

**Suggested Methods of Instruction**

* Role playing
* Viewing of related videos
* Discussion
* Direct Instruction

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Reference books | Digital Electronics: Principles, Devices and Applications  By Anil K. Maini | 5 pcs | 1:5 |
|  | Installation manuals | Assorted Systems component Manufacturer’s manuals and data sheets  Instrumentation Handbooks | 5 pcs | 1:5 |
|  | Charts | Assorted Circuit diagrams  charts | 1 pcs for each | 1:25 |
|  | Software | Assorted simulation software  e.g Deeds, | 25 | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
| 1. | Assorted electronics components | ICs, resistors, capacitors | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Multi-meter, Oscilloscope, Solder guns, breadboards | 25 pcs | 1:1 |
|  | PPEs | Safety boots, overall | 25 pcs | 1:1 |
|  | Function generator |  | 5 pcs | 1:5 |
|  | Variable power supply |  | 5 pcs | 1:5 |
|  | Trainers kit | Assorted logic gate, combinational circuits trainer kits with component Manufacturer’s manuals and data sheets | 5 pcs | 1:5 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |

## ANALOGUE ELECTRONICS APPLICATION I

**UNIT CODE: 0714 541 12A**

**UNIT DESCRIPTION**

This unit describes the competencies required to apply analogue electronics. These competencies include; applying semiconductor theory, applying semiconductor diodes, applying understanding of transistors, applying special semiconductor devices and performing rectification.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Understand semiconductor theory | **10** |
|  | Apply semiconductor diode | **10** |
|  | Apply transistors | **10** |
|  | Apply special semiconductor devices | **10** |
|  | Perform rectification | **10** |
| **TOTAL** | | **50** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Understand semiconductor theory | 1. Atomic structure 2. Structure of the Atom 3. Electron Configuration 4. Ions and Charge Carriers 5. Types of materials 6. Insulators 7. Conductors 8. Semiconductors 9. Semiconductor materials 10. Types of semiconductors materials 11. Intrinsic semiconductors 12. Extrinsic semiconductors     1. n-type extrinsic semiconductor     2. p-type extrinsic semiconductor 13. The pn junction 14. Properties of pn junction 15. Current flow in a forward biased pn junction 16. Current flow in a reverse biased pn junction 17. V-I characteristics of a pn junction | 1. Practical test 2. Project 3. Third Party Report 4. Portfolio of evidence 5. Written test 6. Oral questioning |
| 1. Apply semiconductor diodes. | 1. Introduction to the crystal diode 2. Characteristics of the crystal diode 3. Resistance of a crystal diode 4. Equivalent circuit of the crystal diode 5. Biasing of the crystal diode 6. Foreward biasing 7. Reverse biasing 8. Limitations in the operating conditions of a crystal diode 9. forward current rating 10. PIV 11. power rating 12. Special purpose diodes 13. LED 14. Photodiode 15. Optoisolator 16. Tunnel diode 17. Varactor diode 18. Schockley diode 19. Application of semiconductor diodes | 1. Practical test 2. Third Party Report 3. Portfolio of evidence 4. Written test 5. Oral questioning |
| 1. Apply transistors. | 1. Bipolar junction transistors (BJTs) 2. Types and construction of BJT transistors 3. Operation of NPN and PNP transistors 4. Characteristics of BJTs, i.e., V-I, and gain 5. BJT configurations 6. Common emitter 7. Common base 8. Common collector 9. Characteristics of BJT connections 10. BJT transistor load line analysis 11. DC load line 12. AC load line 13. BJT transistor biasing methods 14. Key terms in transistor biasing (faithful amplification, variation of transistor parameters, stabilisation) 15. Base resistor, emitter bias, collector feedback, voltage divider biasing techniques 16. Field Effect Transistors (FETs) – JFET & MOSFET 17. P and N channels of FETs 18. Operation of FETs 19. Characteristics of FETs 20. Biasing techniques of FETs 21. Application of FETs | 1. Practical test 2. Third Party Report 3. Portfolio of evidence 4. Written test 5. Oral questioning |
| 1. Apply special semiconductor devices. | 1. Special semiconductor devices 2. SCR 3. LASCR 4. TRIAC 5. DIAC 6. SCS 7. UJT 8. Operation principle of special semiconductor devices 9. Schematic symbols of special semiconductor devices 10. Application of special semiconductor devices | 1. Practical test 2. Third Party Report 3. Portfolio of evidence 4. Written test 5. Oral questioning |
| 1. Perform rectification. | 1. Types of rectifiers 2. Half wave rectifiers 3. Full wave rectifiers (center-tap and bridge) 4. Classes of rectifiers 5. Uncontrolled Rectifier 6. Controlled Rectifier 7. Half-Controlled Rectifier 8. Fully-Controlled Rectifier 9. Application of rectifiers 10. Types of converters 11. AC to DC converter (rectifier) 12. DC to AC Converter (Inverter) 13. DC to DC Converter 14. AC to AC Converter 15. Application of converters | 1. Practical test 2. Third Party Report 3. Portfolio of evidence 4. Written test 5. Oral questioning |

**Suggested Methods of Instruction**

* Practical
* Project
* Group discussions
* Demonstration
* Visit to manufacturing and processing industries
* On-job-training
* Charts and Audio-visual presentations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Reference books | Mehta, V. K., & Mehta, R. (2020). Principles of electronics (12 edition). S. Chand and Company Limited, Theraja, B. L., & Theraja, A. K. (2005).  A textbook of electrical technology (1st multicolour ed., Multicolour illustrative ed., 23rd rev. multicoloured ed). S. Chand & Co.  Bird, J. O. (2022). Bird’s electrical and electronic principles and technology (Seventh edition). Routledge, Taylor & Francis Group. | 10 pcs for each book | 1:2.5 |
|  | Software | Assorted simulation software  e.g., Circuit wizard. | 25 | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
| 1. 1. | Electronic components | Breadboards, Stripboards, Jumper wires, Assorted resistors, Assorted capacitors, Assorted MOSFETs, Assorted JFETs, 555 timers, Solder wire, LEDs, Assorted BJT transistors, LDRs, OPAMPs, thermistors, 12V DC motors | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Mult-meter, Solder guns | 25 pcs | 1:1 |
|  | Assorted electrical gadgets | Solder gun, Heat sink, Hot air guns, function generator | 25 pcs | 1:1 |
|  | Assorted measuring instruments | Digital Oscilloscope, | 5 for each category | 1:5 |
|  | Digital Multimeter, |  |  |  |
|  | Digital functional generator |  | 3 pcs | 1:8 |
|  | Laser jet printer |  | 2 pcs | 1:13 |
|  | Power supply | Variable power supply, 5V Power adapters, 9V Power adapters, 12V Power adapters. | 10 pcs | 1:3 |
|  | Trainers kit | Analogue training kits, PWM kit | 5 pcs | 1:5 |
|  | PCB prototyping material | Copper board, ferrite chloride solution, see-through printing paper, HASL finishing PCB | 25 for each category | 1:1 |
|  | Drilling gun |  | 3 pcs | 1:8 |
|  | Work stations |  | 25 | 1:1 |

## ANALOGUE ELECTRONICS APPLICATION II

**UNIT CODE: 0714 541 12A**

**UNIT DURATION: 50 HOURS**

**UNIT DESCRIPTION**

This unit describes the competencies required to apply analogue electronics. These competencies include; applying amplifiers, use of oscillators and application of opto-electronics.

**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 amplifiers | **15** |
|  | Use oscillators | **20** |
|  | Apply opto-electronics | **15** |
| **TOTAL** | | **50** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply amplifiers. | * 1. Classification of amplifiers based on;      1. Stages      2. Coupling method      3. Frequency   2. Types of amplifiers      1. RC coupled amplifiers      2. Power amplifiers      3. Tuned amplifiers   3. Feedback      1. Principle of feedback      2. Positive feedback      3. Negative feedback   4. Operational amplifiers (OPAMPs)      1. Construction of opamps      2. Characteristics of the ideal and practical opamps      3. Opamp configurations         1. Inverting Amplifier         2. Non-Inverting Amplifier         3. Voltage Follower (Buffer)         4. Summing Amplifier         5. Differential Amplifier         6. Instrumentation Amplifier         7. Integrator         8. Differentiator         9. Comparator         10. Schmitt Trigger   5. Application of Amplifiers | 1. Practical test 2. Third Party Report 3. Portfolio of evidence 4. Written test 5. Oral questioning |
| 1. Use oscillators. | * 1. Sinusoidal oscillation   2. Types of sinusoidal oscillations      1. Damped oscillations      2. Undamped oscillations   3. Components of transistor oscillators   4. Essential conditions for oscillations   5. Types of oscillators   Colpitts   * + 1. Hartley     2. Phase shift oscillator     3. Crystal oscillator   1. Applications of oscillators   2. Wave shaping and multivibrator circuits   3. Types of multivibrators      1. Astable      2. Monostable      3. Bistable   4. Passive filters      1. High pass      2. Low pass      3. Band pass   5. Clippers and clampers   6. Applications of wave shaping and multivibrator circuits | 1. Practical test 2. Third Party Report 3. Portfolio of evidence 4. Written test 5. Oral questioning |
| 1. Apply opto-electronics | * 1. Opto-electronic devices      1. LEDs      2. OLED      3. LASER diode      4. Photo transistors      5. Photo diodes      6. Optocoupler      7. LASCR   2. Liquid crystal displays      1. Dynamic scattering LCDs      2. Field effect scattering LCDs      3. LASERs and MASERs      4. Applications of optoelectronics | 1. Practical test 2. Third Party Report 3. Portfolio of evidence 4. Written test 5. Oral questioning |

**Suggested Methods of Instruction**

* Practical
* Project
* Group discussions
* Demonstration
* Visit to manufacturing and processing industries
* On-job-training
* Charts and Audio-visual presentations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Reference books | Mehta, V. K., & Mehta, R. (2020). Principles of electronics (12 edition). S. Chand and Company Limited, Theraja, B. L., & Theraja, A. K. (2005).  A textbook of electrical technology (1st multicolour ed., Multicolour illustrative ed., 23rd rev. multicoloured ed). S. Chand & Co.  Bird, J. O. (2022). Bird’s electrical and electronic principles and technology (Seventh edition). Routledge, Taylor & Francis Group. | 10 pcs for each book | 1:2.5 |
|  | Software | Assorted simulation software  e.g., Circuit wizard. | 25 | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Electronic components | Breadboards, Stripboards, Jumper wires, Assorted resistors, Assorted capacitors, Assorted MOSFETs, Assorted JFETs, 555 timers, Solder wire, LEDs, Assorted BJT transistors, LDRs, OPAMPs, thermistors, 12V DC motors | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Mult-meter, Solder guns | 25 pcs | 1:1 |
|  | Assorted electrical gadgets | Solder gun, Heat sink, Hot air guns, function generator | 25 pcs | 1:1 |
|  | Assorted measuring instruments | Digital Oscilloscope, | 5 for each category | 1:5 |
|  | Digital Multimeter, |  |  |  |
|  | Digital functional generator |  | 3 pcs | 1:8 |
|  | Laser jet printer |  | 2 pcs | 1:13 |
|  | Power supply | Variable power supply, 5V Power adapters, 9V Power adapters, 12V Power adapters. | 10 pcs | 1:3 |
|  | Trainers kit | Analogue training kits, PWM kit | 5 pcs | 1:5 |
|  | PCB prototyping material | Copper board, ferrite chloride solution, see-through printing paper, HASL finishing PCB | 25 for each category | 1:1 |
|  | Drilling gun |  | 3 pcs | 1:8 |
|  | Work stations |  | 25 | 1:1 |

# CORE UNITS OF COMPETENCY

## ELECTRICAL INSTALLATION

**UNIT CODE: 0713 451 10A**

**UNIT DURATION: 120 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform electrical installation

**Unit Description**

This unit specifies the competencies required for performing electrical installation.

Competencies required includes; Performing installation system sizing and installation of electrical system, testing electrical installation and maintaining electrical installation.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Perform installation system sizing | **30** |
|  | Install electrical system | **40** |
|  | Test electrical installation | **30** |
|  | Maintain electrical installation | **20** |
| **TOTAL** | | **120** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform installation system sizing | * 1. Electrical load      1. Electrical & electronic appliances      2. Appliances specifications      3. Calculate Energy requirement & power consumption      4. Lighting load calculations      5. Motor & appliances calculations   2. Protective devices      1. Fuses; Types of fuses, advantages, disadvantages      2. Circuit Breakers: AC & DC MCB, ELCB, RCD      3. Isolators,      4. Ratings of the protective devices &applications   3. Electrical Cables      1. Types, sizes and construction      2. Cable sizing: resistance, current carrying capacity      3. Calculation of voltage drop      4. Factors affecting cable ratings   4. Accessory rating; switches, socket outlets   5. Phase balancing      1. Single phase      2. Three phase      3. Balance loads   6. IEE Regulations | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |
| 1. Install electrical system | * 1. Safety; PPE, handling of equipment   2. Cable management systems   Conduits   * + 1. Bus-bars     2. Raising mains   1. Armored Cable Termination   2. Lightning protection system      1. Domestic      2. Residential      3. Commercial (introduced)   3. Installation of final circuits      1. Distribution panels and switchboards      2. Installation and connection of distribution components      3. Lighting circuits      4. Power circuits      5. Heating circuits      6. Single phase motors   4. Electrical machines      1. 3 phase motors      2. Direct online (DOL)      3. Star Delta      4. Labelling of installation work | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |
| 1. Test electrical installation | * 1. Definition of terms: inspection; testing   2. Visual inspection: Colour codes, labelling, Termination   3. Electrical tests; continuity test; Insulation resistance test polarity test, earth resistance test, earth loop impedance test   4. IEE Regulations |  |
| 1. Maintain electrical installation | * 1. Definition; maintenance; servicing; repair; fault, diagnosis/troubleshooting   2. Importance of maintenance   3. Cause of equipment failure   4. Types of maintenance; preventive, corrective, planned, routine   5. Maintenance schedule; format, content   6. Types of Maintenance Schedules      1. Preventive Maintenance Schedule      2. Corrective Maintenance Schedule      3. Predictive Maintenance Schedule      4. Condition-Based Maintenance Schedule   7. Types of repair aids   8. Maintenance manuals   9. Maintenance tools, equipment, materials and measuring instruments.   10. Identification equipment   11. Common faults in electrical circuits and components       1. Short circuit       2. Open circuit       3. Loose connection       4. Bad connection       5. Earth fault   12. Testing procedures for common faults;   13. Methods of fault location   14. Selection of appropriate test instruments, tools and materials   15. Identification of test points and test parameters   16. Performing maintenance and repair activities       1. Visual Inspection       2. Cleaning       3. Lubrication       4. Testing and calibration       5. Electrical safety checks       6. Reassembly and restoration       7. Updating maintenance documents       8. Disposal of waste materials       9. Cleaning and storage of tools and measuring instruments.       10. Cleaning       11. Storage   17. Maintenance report |  |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions
6. Field trips
7. On-job-training

**Recommended Resources for 25 Trainees**

|  |  |
| --- | --- |
| **Tools**   1. Cutting tools e.g. 2. 25 Hacksaws 3. 25 Stripping knives 4. 25 Side cutters 5. 25 Pliers 6. Measuring tools e.g. 7. 25 Tape measure 8. 25 Tri-square 9. 25 Steel rule 10. 25 Spirit level 11. Fixing tools e.g. 12. Assorted hammers 13. Assorted Screw drivers 14. Fastening tools     1. Assorted spanners and wrenches 15. Lifting and tensioning tools | **Materials and supplies**   * Stationery * Assorted Cables * Assorted protective devices * Assorted solar system components * conduits and trunkings * Accessories * Lubricants * Screw * Adhesives * Cable clips |
| **Equipment**   1. PPEs (Personal Protective Equipment) 2. Measuring equipment 3. 25 digital Multimeter 4. 12 Insulation resistance meter 5. 12 Earth resistance meter 6. 12 Clamp meter 7. 12 AC power supply(to provide lab voltage ie 40-50V AC) 8. Others e.g. 9. 10 Draw wire 10. 10 Bending spring 11. 5 Drilling machines 12. 12 Work stations | **Reference materials**   * British standards (BS 3939;BS7671 * Occupational Safety and Health Act (OSHA) * National Environmental Management Authority (NEMA) regulations * IEEE regulations * EPRA regulation |

# SOLAR PV SYSTEMS DESIGN

**UNIT CODE: 0713 451 11A**

**UNIT DURATION: 90 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Design solar PV systems

**Unit Description**

This unit covers the competencies required to design solar PV systems. Competencies include: surveying solar PV system site, sizing DC and AC components, sizing cables, bus bars and earth strips and also preparing solar PV drawings and bill of quantities.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Survey Solar PV System Site | **10** |
|  | Size DC and AC components | **40** |
|  | Size cables, bus bars and earth strips | **20** |
|  | Prepare Solar PV drawings and Bill of Quantities | **20** |
| **TOTAL** | | **90** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Survey Solar PV System Site | * 1. PPE   2. Site survey map and interpretation   3. Transport logistics   4. Site survey tools, equipment and instruments   5. Site conditions      1. Ground level      2. Weather conditions      3. Soil type      4. Buildings   6. Meaning of solar system   7. Meaning of terms   8. Size and rating of solar panel   9. Factors to consider in site survey Selection and installation      1. Solar system components         1. Solar modules; types, advantages, disadvantages      2. Charge controllers; mppt, pwm, advantages, disadvantages      3. Inverters; mppt, PWM, advantages, disadvantages      4. Batteries; Type Advantages, Disadvantages      5. solar PV accessories      6. solar system wiring   10. Human resource for site surveying   11. Site safety   12. Meteological records interpretation   13. Region Solar potential; insolation, irradiance, wind profile   14. Types of mounting       1. Solar tracking   15. Civil works   16. Site plan   17. Documentation   18. Site survey variables | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |
| 1. Size DC and AC components | * 1. Energy requirement   2. Load estimation   3. System voltage selection criteria; load criteria; daily energy criteria   4. Battery /battery bank sizing; DoD, days of autonomy, battery capacity   5. PV array sizing; PSH, Standard test conditions, watt peak, power tolerance      1. Number of solar cells      2. Solar PV Parameters      3. Solar module selection   6. Charger controller sizing; series fuse sizing   7. Inverter sizing   8. Determination the size of dc & ac protective device and other accessories | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |
| 1. Size cables, bus bars and earth strips | * 1. Determination of load current.   2. Cable/bus bar sizing/balance of system; cable sizes vs voltage drop; allowable voltage drop;   3. Cable size by voltage drop method | * Practical demonstration * Projects * Written tests * Oral Questioning |
| 1. Prepare Solar PV drawings and Bill of Quantities | * 1. Electrical & Solar PV system Symbols   2. Single line diagram      1. Intake point      2. Lighting plan      3. Power circuit      4. Change over switching   3. Schematic diagram   4. Wiring diagram   5. CAD e.g. Aurora, Solar, open solar, helioscope, solar edge, solo, pylon, PV syst, RET screen   6. Bill of quantities; panel schedule/list of materials | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |

**Suggested Methods of Instruction**

Practical

Projects

Demonstrations

Group discussion

Direct instructions

Field trips

On-job-training

**Recommended Resources for 25 Trainees**

|  |  |
| --- | --- |
| **Tools**   1. Excavation tools 2. Measuring tools e.g. 3. 25 Tape measure 4. 1 surveyor tape | **Materials and supplies**   * Stationery * Chalkline |
| **Equipment**   1. PPEs (Personal Protective Equipment) | **Reference materials**   * British standards (BS 3939;BS7671 * Occupational Safety and Health Act (OSHA) * National Environmental Management Authority (NEMA) regulations * IEEE regulations * EPRA regulation * PV system requirement refer KEBS Standards of 1673-1:2004 |

# MODULE FOUR

# BASIC UNITS OF COMPETENCY

## ENTREPRENEURIAL SKILLS

**UNIT CODE: 0413 441 03B**

**Relationship to occupational standards**

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

**Duration of unit:** 40 hours

**Unit Description:**

This unit covers competences required to apply entrepreneurship. Competences include applying financial literacy skills, applying entrepreneurial concepts, identifying entrepreneurship opportunities, applying business legal aspects, developing business innovative strategies, and developing 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 | **10** |
|  | Apply the Entrepreneurial Concept | **5** |
|  | Identify Entrepreneurship Opportunities | **5** |
|  | Apply Business Legal Aspects | **5** |
|  | Innovate Business Strategies | **5** |
|  | Develop A Business Plan | **10** |
| **TOTAL** | | **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 | 1. Observation 2. Project 3. Written assessment 4. Oral assessment 5. Third party report 6. Interviews |
| 1. Apply entrepreneurial concept | * 1. Difference between Entrepreneurs and Business persons   2. Types of entrepreneurs   3. Ways of becoming an entrepreneur Characteristics of Entrepreneurs   4. salaried employment and self-employment   5. Requirements for entry into self-employment   6. Roles of an Entrepreneur in an enterprise   7. Contributions of Entrepreneurship | 1. Observation 2. Project 3. Written assessment 4. Oral assessment 5. Third party report |
| 1. Identify entrepreneurship opportunities | * 1. Sources of business ideas   2. Factors to consider when evaluating business opportunity   3. Business life cycle | 1. Observation 2. Project 3. Written assessment 4. Oral assessment 5. 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 | 1. Observation 2. Project 3. Written assessment 4. Oral assessment 5. 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 | 1. Observation 2. Project 3. Written assessment 4. Oral assessment 5. 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 | 1. Observation 2. Written assessment 3. Project 4. Oral assessment 5. 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 25 Trainees**

* 5 Case studies
* 5 Business plan templates
* 10 Computers
* 1 Overhead projectors
* Internet
* Video clips
* 5 Newspapers and Handouts
* 5 Business Journals
* 25 sets of Writing materials

# COMMON UNITS OF COMPETENCY

## ENGINEERING TECHNICIAN MATHEMATICS II

**UNIT CODE: 0541 441 05A**

**UNIT DURATION: 80 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply engineering technician mathematics

**Unit Description**

This unit describes the competencies required to apply a wide range of engineering technician mathematics. Competencies include applying calculus, applying statistics and probability, applying matrices, applying vector theory and applying complex numbers.

**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 Calculus | **15** |
|  | Apply Statistics and probability | **20** |
|  | Apply matrices | **15** |
|  | Apply Vector Theory | **15** |
|  | Apply Complex Numbers | **15** |
| **TOTAL** | | **80** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply Calculus | * 1. Introduction to calculus   2. Functional notation   3. The gradient of a curve   4. Differentiation from first principles   5. Differentiation of y = axn by the general rule   6. Differentiation of sine and cosine functions   7. Differentiation of eax and ln ax   8. Methods of differentiation      1. Differentiation of common functions      2. Differentiation of a product      3. Differentiation of a quotient      4. Function of a function      5. Successive differentiation   9. Some applications of differentiation      1. Rates of change      2. Velocity and acceleration      3. Turning points   10. Practical problems involving   11. Tangents and normal   12. Small changes   13. Logarithmic differentiation   14. Introduction to logarithmic differentiation       1. Laws of logarithms       2. Differentiation of logarithmic functions       3. Differentiation of further logarithmic functions       4. Differentiation of [f (x)]   15. Integral Calculus   16. Standard integration   17. The process of integration   18. The general solution of integrals of the form axn   19. Definite integrals   20. Integration using algebraic substitutions   21. Algebraic substitutions algebraic substitutions   22. Further worked problems on integration using algebraic substitutions   23. Change of limits   24. Integration using trigonometric substitutions   25. Integration using partial fractions   26. The t = tan θ substitution   27. Integration by parts   28. Numerical integration   29. The trapezoidal rule   30. The mid-ordinate rule   31. Simpson’s rule | 1. Written assessment 2. Practical assessment 3. Oral Questioning |
| 1. Apply statistics and probability | * 1. Measures of central tendency mean, mode and median   2. Measures of dispersion   3. Variance and standard deviation   4. Definition of probability   5. Laws of probability   6. Expectation variance and SD   7. Calculations involving discrete and continuous random variables.   8. Types of distributions      1. Binomial      2. Poisson      3. Normal   9. Mean, variance and SD of probability distributions   10. Application of probability distributions | 1. Written assessment 2. Oral assessment 3. Practical 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Apply matrices I | * 1. Matrix   2. Order of a matrix   3. Square matrix   4. Compatibility in addition and   5. Multiplication of matrices   6. Multiplication of a matrix by a scalar Matrix multiplication   7. Identity matrix   8. Determinant of a 2 x 2 matrix   9. Inverse of a 2 x 2 matrix and   10. Singular matrix   11. Solutions of simultaneous equations in two unknowns by   12. Matrix method   13. Crammer rule | 1. Written assessment 2. Practical assessment 3. Oral Questioning |
| 1. Apply vector theorem | * 1. Vectors and scalar in two and three dimensions      1. Operations on vectors: Addition and subtraction   2. Position vectors   3. Resolution of vectors   4. Scalar and vector product   5. Gradient,   6. Curl   7. Divergence | 1. Practical 2. Project 3. Written tests 4. Oral questioning |
| 1. Apply complex numbers | * 1. Argand diagrams   2. Complex numbers operations   3. De Moivre’s theorem | 1. Practical 2. Project 3. Written tests   Oral questioning |

**Suggested Methods of Instruction**

* Practical
* Demonstrations
* Group discussion
* Direct instructions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Engineering Mathematics by John bird 8th  edition | 5 pcs | 1:5 |
|  | Engineering Mathematics by A.K stround 8th  edition | 5 pcs | 1:5 |
|  | SMP | 25 | 1:1 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 50 m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Charts | Manila papers |  |  |
|  | marker pens | Erasable |  |  |
| **D** | **Tools and Equipment** |  |  |  |
|  | Calculators | Scientific | 25 pcs | 1:1 |

**ELECTRICAL PRINCIPLES 2**

**UNIT CODE:0713 441 06A**

**UNIT DURATION: 70 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply electrical principles

**UNIT DESCRIPTION**

This unit describes competences required to apply electrical principles in their work. It involves applying electrostatics principles, apply concepts of D.C circuit theory and performing electrical measurements.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Applying Electrostatics principles | **20** |
|  | Apply concepts of D.C circuit theory | **20** |
|  | Performing electrical measurements. | **30** |
| **TOTAL** | | **70** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + - 1. Apply Electrostatics principles | * 1. Electrostatics quantities   2. Types of capacitors   3. Concept of charge and electrostatic field   4. Capacitors in series and parallel   5. Measurement of capacitance   6. Application of Capacitors   7. Testing of capacitor | * Practical * Project * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| * + - 1. Apply concepts of D.C circuit theory | * 1. |Resistance and resistivity   2. Parallel and series circuits   3. Basic electrical laws      1. Ohms law      2. Kirchhoff’s theorem | * Practical * Project * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| * + - 1. Perform electrical measurements | * 1. Types of transducers   2. Types of electrical instruments   3. Measurements of electrical quantities using Instruments   4. Calculations involving electrical instruments   5. Instrumental/systematic errors   6. Calculations involving systematic errors | * Practical * Project * Third party report * Portfolio of evidence * Written tests * Oral questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Field trips
* On-job-training

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | J. Bird Electrical and Electronic Principles  V.K. Mehta & R. Mehta Basic Electrical Engineering | 5 pcs | 1:5 |
|  | Installation manuals | Electronic components datasheets | 5 pcs | 1:5 |
|  | Charts | Circuit diagrams  Colour codes | 1 pcs for each | 1:25 |
|  | Scientific Calculators |  | 25 | 1:1 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Laboratory | 100m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Connector wires | Jumper wires, | 5 pkts | 1:5 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Circuit boards | Bread board, copper strip boards | 25 pcs | 1:1 |
|  | Assorted electronic components | Resistors, diodes, capacitors, transistors, ICs, Transformers, Inductors, Batteries | 25 pcs | 1:1 |
|  | Soldering wires |  | 5 rolls | 1:5 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Oscilloscope |  | 5 pcs | 1:5 |
|  | Function generator |  | 5 pcs | 1:5 |
|  | Spectrum analyser |  | 5 pcs | 1:5 |
|  | Variable power supply |  | 5 pcs | 1:5 |
|  | Solder guns |  | 25 pcs | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |

## DIGITAL ELECTRONICS II

**UNIT CODE: 0714 541 13A**

**UNIT DURATION: 50Hours**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Digital Electronics

**Unit Description**

This unit describes competences required to apply digital electronics. Competences include applying knowledge of digital logic circuits, applying knowledge of converters (ADC and DAC) and managing computer memories.

**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 knowledge of digital logic circuits | **15** |
|  | Apply knowledge of advance digital logic and converter circuits | **20** |
|  | Manage computer memories | **15** |
| **TOTAL** | | **50** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply knowledge of digital logic circuits | * 1. Combinational logic circuits design and minimization   2. Logic families.      1. Bipolar Families      2. MOS Families      3. Hybrid Family   3. Sequential logic circuits   Flip flops | 1. Observation 2. Written test 3. Practical 4. Demonstration 5. Oral questioning 6. Third party report |
| 1. Apply knowledge of advance digital logic and converter circuits | * 1. Counters   2. Data handling devices      1. Decoders      2. Encoders      3. Multiplexers      4. Demultiplexers      5. Shift registers   3. Arithmetic circuits   4. Digital converters (ADC)(DAC) | 1. Observation 2. Written test 3. Practical 4. Demonstration 5. Oral questioning 6. Third party report |
| 1. Manage computer memories | * 1. Introduction to Computer Memory systems   2. Types of memory devices      1. RAMs      2. ROMs      3. EEPROM      4. EPROM   3. Memory organization.   4. Memory expansion | 1. Observation 2. Written test 3. Practical 4. Demonstration 5. Oral questioning 6. Third party report |

**Suggested Methods of Instruction**

* Role playing
* Viewing of related videos
* Discussion
* Direct Instruction

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Reference books | Digital Electronics: Principles, Devices and Applications  By Anil K. Maini | 5 pcs | 1:5 |
|  | Installation manuals | Assorted Systems component Manufacturer’s manuals and data sheets  Instrumentation Handbooks | 5 pcs | 1:5 |
|  | Charts | Assorted Circuit diagrams  charts | 1 pcs for each | 1:25 |
|  | Software | Assorted simulation software  e.g Deeds, | 25 | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Assorted electronics components | ICs, resistors, capacitors | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver,Multi-meter, Oscilloscope, Solder guns, breadboards | 25 pcs | 1:1 |
|  | PPEs | Safety boots, overall | 25 pcs | 1:1 |
|  | Function generator |  | 5 pcs | 1:5 |
|  | Variable power supply |  | 5 pcs | 1:5 |
|  | Trainers kit | Assorted logic gate, combinational circuits trainer kits with component Manufacturer’s manuals and data sheets | 5 pcs | 1:5 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |

# CORE UNITS OF COMPETENCY

## SOLAR PV **PUMPS SYSTEM INSTALLATION**

**UNIT CODE: 0713 451 13A**

**UNIT DURATION: 80 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: install solar PV pump systems

**Unit Description**

This unit covers the competencies required to install solar PV pumps system. Competencies include: surveying solar PV system site, sizing solar PV pump system, installing solar PV pump system components, testing solar PV pump system and maintaining solar PV pump system.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Survey Solar PV System Site | **10** |
|  | Size solar PV pump system | **30** |
|  | Install Solar PV pump system components | **20** |
|  | Test solar PV pump system | **10** |
|  | Maintain solar PV pump system | **10** |
| **TOTAL** | | **80** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Survey Solar PV System Site | * 1. PPE   2. Site survey map and interpretation   3. Transport logistics   4. Site survey tools, equipment and instruments   5. Site conditions      1. Ground level      2. Weather conditions      3. Soil type      4. Buildings   6. Meaning of solar system   7. Meaning of terms   8. Size and rating of solar panel   9. Factors to consider in site survey Selection and installation      1. Solar system components         1. Solar modules; types, advantages, disadvantages      2. Charge controllers; mppt, pwm, advantages, disadvantages      3. Inverters; mppt, PWM, advantages, disadvantages      4. solar PV accessories      5. solar system wiring   10. Human resource for site surveying   11. Site safety   12. Meteological records interpretation   13. Region Solar potential; insolation, irradiance, wind profile   14. Types of mounting   15. Civil works   16. Site plan   17. Documentation   18. Site survey variables (rearrangement) | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |
| 1. Size solar PV pump system | * 1. System design consideration      1. Water demand      2. Water source      3. Design flow rate      4. Water storage      5. Total dynamic head      6. Location PV panels   2. Solar resource   3. Water pumping system sizing   4. Energy requirement; pump rating   5. Load estimation   6. System voltage selection criteria; load criteria; daily energy criteria   7. PV array sizing; PSH, Standard test conditions, watt peak, power tolerance      1. Number of solar cells      2. Solar IV Parameters      3. Solar module selection   8. Inverter sizing   9. Determination the size of DC & ac protective device and other accessories   10. Power conditioning   11. Sizing software       1. COMPASS       2. Grundfos Product Centre       3. PVSyst       4. HOMER | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |
| 1. Install Solar PV pump system components | * 1. Revolution of solar pumping   2. Advantages of solar pumping   3. Solar pumping applications   4. Solar pumping system      1. Three phase Pumps and motors; ac; dc      2. Types of pumps; Positive displacement: volumetric, helical rotor pump      3. Centrifugal pump      4. Submersible pump      5. Floating pumps   5. Power conditioning   6. System design consideration      1. Water demand      2. Water source      3. Design flow rate      4. Water storage      5. Total dynamic head      6. Location of PV panels      7. Solar resource | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |
| 1. Test solar PV pump system | * 1. Visual inspection checklist   2. Tests      1. Continuity test      2. Insulation resistance tes5t      3. Polarity test      4. Earth resistance tests | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |
| 1. Maintain solar PV pump system | * 1. Maintenance schedule   2. Maintenance and care of Solar modules   3. Inverter maintenance   4. Balance of system maintenance   5. Faults      1. Ground faults      2. Short circuit      3. Open circuit   6. Control panel maintenance   7. Bonding/ grounding system   8. Troubleshooting procedures      1. Load troubleshooting      2. System trouble shooting case studies   9. Solar PV system monitoring   10. Signs and warning labels   11. Maintenance records       1. Maintenance checklist       2. Maintenance reports | * Written assessment * Practical assessment * Projects * Oral Questioning * Third party report * Portfolio of evidence |

**Suggested Methods of Instruction**

1. Practical
2. Projects
3. Demonstrations
4. Group discussion
5. Direct instructions
6. Field trips
7. On-job-training

**Recommended Resources for 25 Trainees**

|  |  |
| --- | --- |
| **Tools**   1. Inclinometer 2. Tape measure 3. MC4 Climping tool 4. Spanner 5. Pliers 6. Side cutter 7. Ladder 8. Module mover 9. ballast block carrier 10. Vent pipe cutter | **Materials and supplies**   1. Stationery 2. Mc4 clips 3. Clamp clips 4. Cable ties 5. Conduits 6. Bolt and nuts 7. Wall plug 8. Mounting brackets 9. cable lugs 10. racks 11. solar spacer 12. mounting spacer 13. ground mount pipe caps 14. solar panel cleaning kit 15. Locking tool clip 16. Permanent roof anchor |
| **Equipment**   1. Digital Multimeter 2. Clamp meter 3. PPEs (Personal Protective Equipment) 4. Thermal camera 5. Continuity tester 6. Irradiance meter 7. Insulation resistance tester 8. Polarity tester 9. Earth resistance tester 10. Earth loop impedance tester | **Reference materials**   1. British standards (BS 3939;BS7671 2. Occupational Safety and Health Act (OSHA) 3. National Environmental Management Authority (NEMA) regulations 4. IEEE regulations 5. EPRA regulation 6. PV system requirement refer KEBS Standards of 1673-1:2004 |

## SECURITY SYSTEM

**UNIT CODE: 0713 451 14A**

**UNIT DURATION: 70 HOURS**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: perform security system

**Unit Description**

This unit covers competences required in performing security system installation**.** Competences include applying health and safety measures, installing security systems, testing security system installation and maintaining security system installations.

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **S/NO** | **Learning Outcome** | **Duration (Hours)** |
|  | Install security Systems | **20** |
|  | Test security system installation | **20** |
|  | Maintain security system installation | **30** |
| **TOTAL** | | **70** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Install Security Systems | 1. Types of cables in security system    1. Factors to consider in security system cable laying    2. Segregation in cable laying       1. Importance segregations    3. Security system installation    4. CCTV system       1. Identification of materials and components          1. Cables          2. Conduits, trunking etc          3. CCTV system components          4. Backup system (data and power)    5. Specification of tools, equipment and materials       1. Tolerance/ range       2. Make / model       3. Size       4. Class    6. Wiring CCTV system       1. Schematic diagram       2. Wiring diagram    7. Alarm systems       1. Fire alarm       2. Burglar alarm    8. Identification of materials and components       1. Cables       2. Conduits, trunking etc       3. Alarm system components       4. Backup system(power)    9. Specification of tools, equipment and materials       1. Tolerance/range       2. Make/model       3. Size       4. Class    10. Wiring alarm system        1. Schematic diagram        2. Wiring diagram    11. Electric fence    12. identification of materials and components        1. Cables        2. Conduits, trunking etc        3. Electric fence components        4. Backup system(power)    13. Specification of tools, equipment and materials        1. Tolerance/ range        2. Make / model        3. Size        4. Class    14. Wiring electric fence system        1. Schematic diagram        2. Wiring diagram    15. Insulation classes of enclosures e.g.        1. IP 44 (Ingress protection)        2. IP 55        3. IP 65        4. IP 66        5. IP 67    16. Cable labelling    17. Cable termination        1. Importance of termination    18. Tools used in cable termination e.g.        1. Strip Knife    19. Security system integration with other components    20. Housekeeping practices   **Practical content**   * 1. Install security system   2. CCTV system   3. Alarm systems   4. Electric fence system   5. Coding/configuring security system   6. Proper disposal of waste material   **Practical content**   * 1. Install security system   2. Coding security system   3. Proper disposal of waste material | 1. Practical 2. Project 3. Third party report 4. Portfolio of evidence 5. Written tests 6. Oral questioning |
| 1. Test security system installation | **Theory content**   * 1. Visual inspection   2. Types of tests in security system e.g.      1. Insulation test      2. Short circuit test      3. Continuity test      4. Arming and disarming tests      5. Physical inspection of the system   3. Test results documentation   4. Security system commissioning   **Practical content**   * 1. Test performance of system as per design specifications | 1. Practical 2. Project 3. Third party report 4. Portfolio of evidence 5. Written tests 6. Oral questioning |
| 1. Maintain security system installation | **Theory content**   * 1. Maintenance schedule preparation   2. System maintenance check list preparation   3. Maintenance tools and equipment selection   4. Inspection and tests   5. Faults diagnosis   6. Faults rectification   7. Maintenance reports documentation   **Practical Content**   * 1. Perform security system installation maintenance as per IEEE regulations   2. Inspection and tests   3. Faults diagnosis   4. Faults rectification   5. Maintenance reports documentation | 1. Practical 2. Project 3. Third party report 4. Portfolio of evidence 5. Written tests 6. Oral questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Field trips
* On-job-training

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | B. Scaddan Electrical installation work  J. Hyde Electrical installation Principles and Practices | 5 pcs | 1:5 |
|  | Installation manuals | Equipment manuals  Control panel manuals | 5 pcs | 1:5 |
|  | Charts | Single line diagram  Circuit diagrams  Colour codes | 1 pcs for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Assorted Electrical cables |  | 5 rolls | 1:5 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Patrice boxes, Circuit breakers | 25 pcs | 1:1 |
|  | Assorted CCTV components | Cameras, Digital video recorder, power supply unit, TFT monitors, | 5 pcs | 1:5 |
|  | Security system components | Alarm panels, magnetic sensors, vibration sensors, motion detectors | 5 pcs | 1:5 |
|  | Fire Alarm system components | Addressable control panel, fire and heat detectors, call points, buzzers | 5 pcs | 1:5 |
|  | Electric fence components | Energizer, Insulators, wires, support | 5 pcs | 1:5 |
|  | Pipes and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Clamp meters |  | 5 pcs | 1:5 |
|  | Earth resistance meter |  | 5 pcs | 1:5 |
|  | Stocks & Dies |  | 5 pcs | 1:5 |
|  | Vices |  | 5 pcs | 1:5 |
|  | Wire fasteners |  | 5 pcs | 1:5 |
|  | Oscilloscope |  | 5 pcs | 1:5 |
|  | Pipe bending Machine |  | 5 pcs | 1:5 |
|  | Bending spring |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |
|  | Installation boards |  | 13 pcs | 1:2 |