

**TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION COUNCIL (TVET CDACC)**

**NATIONAL OCCUPATIONAL STANDARDS**

**FOR**

**INDUSTRIAL CONTROLS AND INSTALLATIONS TECHNICIAN**

**LEVEL 6**



TVET CDACC

PO BOX 15745-00100

NAIROBI

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**Council Secretary/CEO**

**TVET Curriculum Development, Assessment and Certification Council**

**P.O. Box 15745–00100 Nairobi, Kenya**

**Email:** **info@tvetcdacc.go.ke**

# FOREWORD

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

Reforms in the education sector are necessary for the achievement of Kenya Vision 2030 and meeting the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution and this resulted in the formulation of the Policy Framework for Reforming Education and Training (Sessional Paper No. 4 of 2016). A key feature of this policy is the radical change in the design and delivery of the TVET training. The policy document requires that training in TVET shall be competency based, curriculum development shall be industry led, certification shall be based on demonstration of competence and mode of delivery shall allow for multiple entry and exit in TVET programmes.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that these Occupational Standards were developed for the purpose of developing a competency-based curriculum for Industrial Controls and Installations. These Occupational Standards will also be the basis for assessment of an individual for competence certification.

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

**PRINCIPAL SECRETARY, VOCATIONAL AND TECHNICAL TRAINING**

**MINISTRY OF EDUCATION**

# PREFACE

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

The Technical and Vocational Education and Training Act No. 29 of 2013 and the Sessional Paper No. 4 of 2016 on Reforming Education and Training in Kenya, emphasized the need to reform curriculum development, assessment and certification. This called for shift to CBET to address the mismatch between skills acquired through training and skills needed by industry as well as increase the global competitiveness of Kenyan labour force.

The TVET Curriculum Development, Assessment and Certification Council (TVET CDACC), in conjunction with Electrical Engineering Sector Skills Advisory Committee (SSAC) have developed these Occupational Standards for Industrial Controls and Installations Technician. These occupational standards will be the basis for development of competency-based curriculum for Industrial Controls and Installations. These Standards will also be the basis for assessment of an individual for competence certification.

The occupational standards are designed and organized with clear performance criteria for each element of a unit of competency. These standards also outline the required knowledge and skills as well as evidence guide.

I am grateful to Council members, Council Secretariat, Electrical Engineering SSAC and all those who participated in the development of these occupational standards.

**CHAIRPERSON, TVET CDACC**

# ACKNOWLEDGMENT

These Occupational Standards were developed through combined effort of various stakeholders from private and public organizations. I am sincerely thankful to the management of these organizations for allowing their staff to participate in this course. I wish to acknowledge the invaluable contribution of industry players who provided inputs towards the development of these Standards.

I thank TVET Curriculum Development, Assessment and Certification Council (TVET CDACC) for providing guidance on the development of these Standards. My gratitude goes to the Electrical Engineering Sector Skills Advisory Committee (SSAC) members for their contribution to the development of these Standards. I thank all the individuals and organizations who participated in the validation of these Standards.

I acknowledge all institutions which in one way or another contributed to the success of development of these Standards.

**CHAIRPERSON**

**ELECTRICAL ENGINEERING SECTOR SKILLS ADVISORY COMMITTEE**

.

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#

# ABBREVIATIONS ANS ACRONYMS

A Control version

AIDS Acquired Immunodeficiency Syndrome

BC Basic Competency

CAD Computer Aided Design

CBET Competency Based Education and Training

CC Common Competency

CCTV Closed Circuit Tele Vision

CDACC Curriculum Development Assessment Certification Council

CEO Council Secretary

CPU Central Processing Unit

CR Core Unit

EHS Environment, Health and Safety

HIV Human Immuno-Deficiency Virus

HVAC Heating, Ventilation and Air Conditioning

IBMS Integrated Building Management System

ICT Information Communication Technology

IEE Institute of Electrical Engineers

KEBS Kenya Bureau of Standards

Ken Gen Kenya Generating Company

KPLC Kenya Power and Lighting Company

NCA National Construction Authority

OS Occupational Standard

OSH Occupational Safety and Health

OSHA Occupational Safety and Health Act

PESTEL Political Environmental Social Technological Economic Legal

PLC Programmable Logic Controller

PPE Personal Protective Equipment

PV Photo Voltaic

SCADA Supervisory Control and Data Acquisition

SOPStandard Operating Procedure

SSAC Sector Skills Advisory Committee

SWOT Strength Weakness Opportunity Threat

TVET Technical and Vocational Education and Training

WIBA Work injury benefits Act

**KEY TO UNIT CODE**

 **ENG/OS/IC/BC/01/6/A**

Industry or sector

Occupational Standards

Occupational area

Type of competency

Competency number

Competency level

version

# OVERVIEW

The Industrial Controls and Installations Level 6 qualification consists of competencies that a person must achieve to enable him/her to manage motor control systems,manage programmable logic controllers and SCADA systems, manage instrumentation and process control systems, manage high voltage systems and analyse alternative energy systems.

The course consists of the following basic, common and core units of competency as shown below:

**Basic Units of Competency**

|  |  |
| --- | --- |
| **Unit Code** | **Unit Title** |
| ENG/OS/IC/BC/01/6/A | Demonstrate Communication Skills |
| ENG/OS/IC/BC/02/6/A | Demonstrate Digital Literacy |
| ENG/OS/IC/BC/03/6/A | Demonstrate Entrepreneurial Skills |
| ENG/OS/IC/BC/04/6/A | Demonstrate Employability Skills |
| ENG/OS/IC/BC/05/6/A | Demonstrate Environmental Literacy |
| ENG/OS/IC/BC/06/6/A | Demonstrate Occupational Safety and Health Practices |

**Common Units of Competency**

|  |  |
| --- | --- |
| **Unit Code** | **Unit Title** |
| ENG/OS/IC/CC/01/6/A | Apply Engineering Mathematics |
| ENG/OS/IC/CC/02/6/A | Apply Workshop Processes |
| ENG/OS/IC/CC/03/6/A | Electrical principles |
| ENG/OS/IC/CC/04/6/A | Prepare and Interpret Technical Drawing |

**Core Units of Competency**

|  |  |
| --- | --- |
| **Unit Code** | **Unit Title** |
| ENG/OS/IC/CR/1/6/A | Manage Motor Control Systems |
| ENG/OS/IC/CR/2/6/A | Manage Programmable Logic Controllers and SCADA Systems |
| ENG/OS/IC/CR/3/6/A | Manage Instrumentation and Process Control Systems |
| ENG/OS/IC/CR/4/6/A | Manage High Voltage Systems |
| ENG/OS/IC/CR/5/6/A | Analyse Alternative Energy Systems |

#

# BASIC UNITS OF COMPETENCY

# DEMONSTRATE COMMUNICATION SKILLS

**UNIT CODE:** ENG/OS/IC/BC/01/6/A

**UNIT DESCRIPTION**

This unit covers the competencies required to demonstrate communication skills. It involves meeting communication needs of clients and colleagues, developing communication strategies, establishing and maintaining communication pathways, conducting interviews, facilitating group discussion and representing the organization.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT** These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Meet communication needs of clients and colleagues
 | 1. Specific communication needs of clients and colleagues are identified and met based on workplace requirements
2. Different communication approaches are identified and applied according to clients’ needs
3. Conflict is identified and addressed as per the standards of the organization
 |
| 1. Develop communication strategies
 | * 1. Strategies for effective internal and external dissemination of information are developed as per organization’s requirements
	2. Special communication needs are considered in developing strategies according workplace procedures
	3. ***Communication strategies*** are analyzed, evaluated and revised based the workplace needs
 |
| 1. Establish and maintain communication pathways
 | * 1. Pathways of communication are established as per organization policy
	2. Pathways are maintained and reviewed according to organization procedures
 |
| 1. Promote use of communication strategies
 | * 1. Information is provided to all areas of the organization as per strategy requirements
	2. Effective communication techniques are articulated and modeled according work requirements
	3. Personnel are given guidance about adapting communication strategies as per organization procedures
 |
| 1. Conduct interview
 | 1. A range of appropriate communication strategies are employed in ***interview situations*** based on the workplace requirements
2. Records of interviews are made and maintained in accordance with organizational procedures
3. Effective questioning, listening and nonverbal communication techniques are used as per needs
 |
| 1. Facilitate group discussion
 | 1. Mechanisms to enhance ***effective group interaction*** are identified and implemented according to workplace requirements
2. Strategies to encourage group participation are identified and used as per organizations’ procedures
3. Meetings objectives and agenda are set and followed based on workplace requirements
4. Relevant information is provided and feedback obtained according to set protocols
5. Evaluation of group communication strategies is undertaken in accordance with workplace guidelines
6. Specific communication needs of individuals are identified and addressed as per individual needs
 |
| 1. Represent the organization
 | 1. 7Relevant presentation are researched and presented based on internal or external communication forums requirements
2. Presentation is delivered in a clear and sequential manner as per the predetermined time
3. Presentation is made as per appropriate media
4. Difference views are respected based on workplace procedures
5. Written communication is done as per organizational standards
6. Inquiries are responded according to organizational standard
 |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Communication strategies may include but not limited to:
 | * Language switch
* Comprehension check
* Repetition
* Asking confirmation
* Paraphrase
* Clarification request
* Translation
* Restructuring
* Approximation
* Generalization
 |
| 1. Effective group interaction may include but not limited to:
 | * Identifying and evaluating what is occurring within an interaction in a nonjudgmental way
* Using active listening
* Making decision about appropriate words, behavior
* Putting together response which is culturally appropriate
* Expressing an individual perspective
* Expressing own philosophy, ideology and background and exploring impact with relevance to communication
 |
| 1. Situations may include but not limited to:
 | * Establishing rapport
* Eliciting facts and information
* Facilitating resolution of issues
* Developing action plans
* Diffusing potentially difficult situations
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Active listening
* Interpretation
* Negotiation
* Writing

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Communication process
* Dynamics of groups
* Styles of group leadership
* Key elements of communications strategy

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency
 | Assessment requires evidence that the candidate: 1. Developed communication strategies to meet the organization requirements and applied in the workplace
2. Established and maintained communication pathways for effective communication in the workplace
3. Used communication strategies involving exchanges of complex oral information
 |
| 1. Resource Implications
 | The following resources should be provided: 1. Access to relevant workplace or appropriately simulated environment where assessment can take place
2. Materials relevant to the proposed activity or tasks
 |
| 1. Methods of Assessment
 | Competency in this unit may be assessed through: 1. Direct observation
2. Oral questioning
3. Written texts
 |
| 1. Context of Assessment
 | Competency may be assessed:1. On-the-job
2. Off-the –job
3. During Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

# DEMONSTRATE NUMERACY SKILLS

**UNIT CODE:** ENG/OS/IC/BC/02/6/A

**UNIT DESCRIPTION**

This unit describes the competencies required to demonstrate numeracy skills. It involves; applying a wide range of mathematical calculations for work; applying ratios, rates and proportions to solve problems; estimating, measuring and calculating measurement for work; using detailed maps to plan travel routes for work; using geometry to draw and construct 2D and 3D shapes for work; collecting, organizing and interpreting statistical data; using routine formula and algebraic expressions for work and using common functions of a scientific calculator.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT** These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms*** ***are elaborated in the Range.*** |
| 1. Apply a wide range of mathematical calculations for work
 | * 1. Mathematical information embedded in a range of workplace tasks and texts is extracted as per workplace procedures.
	2. Mathematical information is interpreted and comprehended as per job specifications
	3. A range of mathematical and problem solving processes are selected and used as per job specification
	4. Different forms of fractions, decimals and percentages are flexibly used as per SOPs
	5. Calculation performed with positive and negative numbers as per SOPs
	6. Numbers are expressed as powers and roots and are used in calculations as per SOPs
	7. Calculations done using routine formulas as per SOPs
	8. Estimation and assessment processes are used to check outcome as per workplace procedures
	9. Mathematical language is used to discuss and explain the processes, results and implications of the task as per workplace procedures
 |
| 1. Use and apply ratios, rates and proportions for work
 | * 1. Information regarding ratios, rates and proportions extracted from a range of workplace tasks and texts as per SOPs
	2. Mathematical information related to ratios, rate and proportions is analysed as per SOPs
	3. Problem solving processes are used to undertake the task as per workplace procedures
	4. Equivalent ratios and rates are simplified as per SOPs
	5. Quantities are calculated using ratios, rates and proportions as per SOPS
	6. Graphs, charts or tables are constructed to represent ratios, rates and proportions as per SOPs
	7. The outcomes reviewed and checked as per job specifications
	8. Information is record using mathematical language and symbols as per workplace procedures
 |
| 1. Estimate, measure and calculate measurement for work
 | * 1. Measurement information embedded in workplace texts and tasks are extracted and interpreted as per job specifications
	2. Appropriate workplace measuring equipment are identified and selected as per job specifications
	3. Accurate measurements are estimated and made as per SOPs
	4. The area of ***2D shapes*** including compound shapes are calculated as per SOPs
	5. The volume of 3D shapes is calculated using relevant formulas as per SOPs
	6. Sides of right angled triangles are calculated using Pythagoras’ theorem as per SOPs
	7. conversions are perform between units of measurement as per job specification
	8. Problem solving processes are used to undertake the task as per workplace Procedures
	9. The measurement outcomes are reviewed and checked as per workplace procedures
	10. Information is recorded using mathematical language and symbols appropriate for the task as per workplace procedures
 |
| 1. Use detailed maps to plan travel routes for work
 | * 1. Different types of maps are identified and interpreted as per job requirements
	2. Key features of maps are identified as per job requirements
	3. Scales are identified and interpreted as per job requirements
	4. Scales are applied to calculate actual distances
	5. Positions or locations are determined using directional information as per job requirements
	6. Routes are planned by determining directions and calculating distances, speeds and times as per job requirements
	7. Information is gathered and identified and relevant factors related to planning a route checked as per job requirements
	8. Relevant equipment is select and checked for accuracy and operational effectiveness as per job requirements
	9. Task is planned and recorded using specialized mathematical language and symbols appropriate for the task as per job requirements
 |
| 1. Use geometry to draw 2D shapes and construct 3D shapes for work
 | * 1. A range of 2D shapes and 3D shapes and their uses in work contexts is identified as per job specifications
	2. Features of 2D and 3D shapes are named and described as per job specifications
	3. Types of angles in 2D and 3D shapes are identified as per job specifications
	4. Angles are drawn, estimated and measured using geometric instruments as per job requirements
	5. Angle properties of 2D shapes are named and identified as per SOPs
	6. Angle properties are used to evaluate unknown angles in shapes as per SOPs
	7. Properties of perpendicular and parallel lines are applied to shapes as per SOPs
	8. Understanding and use of symmetry is demonstrated as per SOPs
	9. Understanding and use of similarity is demonstrated as per SOPs
	10. The workplace tasks and mathematical processes required are identified as per workplace procedures
	11. 2D shapes is drawn for work as per job specification
	12. 3D shapes is constructed for work as per job specification
	13. The outcomes are reviewed and checked as per workplace procedures
	14. Specialized mathematical language and symbols appropriate for the task are used as per SOPs
 |
| 1. Collect, organize, and interpret statistical data for work
 | * 1. Workplace issue requiring investigation are identified as per workplace procedures
	2. Audience / population / sample unit is determined as per workplace procedures as per workplace procedures
	3. Data to be collected is identified as per workplace procedures
	4. Data collection method is selected as per workplace procedures
	5. Appropriate statistical data is collected and organized as per SOPs
	6. Data is illustrated in appropriate formats as per SOPs
	7. The effectiveness of different types of graphs are compared as per SOPs
	8. The summary statistics for collected data is calculated as per SOPs
	9. The results / findings are interpreted as per SOPs
	10. Data is checked to ensure that it meets the expected results and content as per workplace procedures
	11. Information from the results including tables, graphs and summary statistics is extracted and interpreted as per workplace procedure
	12. Mathematical language and symbols are used to report results of investigation as per workplace procedure
 |
| 1. Use routine formula and algebraic expressions for work
 | * 1. Understanding of informal and symbolic notation, representation and conventions of algebraic expressions is demonstrated as per SOPs
	2. Simple algebraic expressions and equations are developed as per job specification
	3. Operate on algebraic expressions as per job requirement
	4. Algebraic expressions are simplified as per job requirement
	5. Substitution into simple routine equations is done as per SOPs
	6. Routine formulas used for work tasks are identified and comprehended as per SOPs
	7. Routine formulas are evaluate by substitution as per SOPs
	8. Routine formulas transposed as per SOPs
	9. Appropriate formulas are identified and used for work related tasks as per workplace procedures
	10. Outcomes are checked and result of calculation used as per workplace procedures
 |
| 1. Use common functions of a scientific calculator for work
 | * 1. Required numerical information to perform tasks is located as per job specification
	2. The order of operations and function keys necessary to solve mathematical calculation are determined as per job specification
	3. Function keys on a scientific calculator are identified and used as per SOPs
	4. Estimations are referred to check reasonableness of problem solving process as per workplace procedures
	5. Appropriate mathematical language, symbols and conventions are used to report results as per workplace procedures
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. 2D shapes may include but not limited may include but not limited to:
 | * Triangles
* Square
* Rectangle
* Triangle
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Measuring
* Logical thinking
* Computing
* Drawing of graphs
* Applying mathematical formulas
* Analytical

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Types of common shapes
* Differentiation between two dimensional shapes / objects
* Formulae for calculating area and volume
* Types and purpose of measuring instruments
* Units of measurement and abbreviations
* Fundamental operations (addition, subtraction, division, multiplication)
* Rounding techniques
* Types of fractions
* Different types of tables and graphs
* Meaning of graphs, such as increasing, decreasing, and constant value
* Preparation of basic data, tables & graphs

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency
 | Assessment requires evidence that the candidate:1. Developed communication strategies to meet the organization requirements and applied in the workplace
2. Established and maintained communication pathways for effective communication in the workplace
3. Used communication strategies involving exchanges of complex oral information
 |
| 1. Resource Implications
 | The following resources should be provided:1. Access to relevant workplace or appropriately simulated environment where assessment can take place
2. Materials relevant to the proposed activity or tasks
 |
| 1. Methods of Assessment
 | Competency in this unit may be assessed through:1. Observation
2. Oral questioning
3. Written test
4. Portfolio of Evidence
5. Interview
6. Third party report
 |
| 1. Context of Assessment
 | Competency may be assessed:1. On-the-job
2. Off-the –job
3. During Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

**DEMONSTRATE DIGITAL LITERACY**

**UNIT CODE:** ENG/OS/IC/BC/03/6/A

**UNIT DESCRIPTION**

This unit describes competencies required to demonstrate digital literacy. It involves, identifying computer software and hardware, applying security measures to data, hardware, and software in automated environment, applying computer software in solving task, applying internet and email in communication at workplace, applying desktop publishing in official assignments and preparing presentation packages.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT** These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Identify appropriate computer software and hardware
 | * 1. Concepts of ICT are determined in accordance with computer equipment
	2. Classifications of computers are determined in accordance with manufacturers specification
	3. Appropriate computer software is identified according to manufacturer’s specification
	4. Appropriate computer hardware is identified according to manufacturer’s specification
	5. Functions and commands of operating system are determined in accordance with manufacturer’s specification
 |
| 1. Apply security measures to data, hardware, software in automated environment
 | * 1. ***Data security and privacy are classified*** in accordance with the prevailing technology
	2. ***Security threats*** reidentified ***and control measures*** are applied in accordance with laws governing protection of ICT
	3. Computer threats and crimes are detected in accordance to Information Management security guidelines
	4. Protection against computer crimes is undertaken in accordance with laws governing protection of ICT
 |
| 1. Apply computer software in solving tasks
 | * 1. ***Word processing concepts*** are applied in resolving workplace tasks, report writing and documentation as per the job requirements
	2. ***Word processing utilities*** are applied in accordance with workplace procedures
	3. Worksheet layout is prepared in accordance with work procedures
	4. Worksheet is built and data manipulated in the worksheet in accordance with workplace procedures
	5. Continuous data manipulated on worksheet is undertaken in accordance with work requirements
	6. Database design and manipulation is undertaken in accordance with office procedures
	7. Data sorting, indexing, storage, retrieval and security is provided in accordance with workplace procedures
 |
| 1. Apply internet and email in communication at workplace
 | * 1. Electronic mail addresses are opened and applied in workplace communication in accordance with office policy
	2. Office internet functions are defined and executed in accordance with office procedures
	3. ***Network configuration*** is determined in accordance with office operations procedures
	4. Official World Wide Web is installed and managed according to workplace procedures
 |
| 1. Apply Desktop publishing in official assignments
 | * 1. Desktop publishing functions and tools are identified in accordance with manufactures specifications
	2. Desktop publishing tools are developed in accordance with work requirements
	3. Desktop publishing tools are applied in accordance with workplace requirements
	4. Typeset work is enhanced in accordance with workplace standards
 |
| 1. Prepare presentation packages
 | * 1. Types of presentation packages are identified in accordance with office requirements
	2. Slides are created and formulated in accordance with workplace procedures
	3. Slides are edited and run-in accordance with work procedures
	4. Slides and handouts are printed according to work requirements
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Appropriate computer hardware may include but not limited to:
 | Collection of physical parts of a computer system such as:1. Computer case, monitor, keyboard, and mouse
2. All the parts inside the computer case, such as the hard disk drive, motherboard and video card
 |
| 1. Data security and privacy may include but not limited to:
 | 1. Confidentiality of data
2. Cloud computing
3. Integrity -but-curious data surfing
 |
| 1. Security and control measures may include but not limited to:
 | 1. Counter measures against cyber terrorism
2. Risk reduction
3. Cyber threat issues
4. Risk management
5. Pass-wording
 |
| 1. Security threats may include but not limited to:
 | 1. Cyber terrorism
2. Hacking
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

1. Analytical skills
2. Interpretation
3. Typing
4. Communication
5. Computing (applying fundamental operations such as addition, subtraction, division and multiplication)
6. Using calculator
7. Basic ICT skills

**Required Knowledge**

The individual needs to demonstrate knowledge of:

1. Software concept
2. Functions of computer software and hardware
3. Data security and privacy
4. Computer security threats and control measures
5. Technology underlying cyber-attacks and networks
6. Cyber terrorism
7. Computer crimes
8. Detection and protection of computer crimes
9. Laws governing protection of ICT
10. Word processing;
* Functions and concepts of word processing.
* Documents and tables creation and manipulations
* Mail merging
* Word processing utilities
1. Spread sheets;
* Meaning, formulae, function and charts, uses and layout
* Data formulation, manipulation and application to cells
1. Database;
* Database design, data manipulation, sorting, indexing, storage retrieval and security
1. Desktop publishing;
* Designing and developing desktop publishing tools
* Manipulation of desktop publishing tools
* Enhancement of typeset work and printing documents
1. Presentation Packages;
* Types of presentation Packages
* Creating, formulating, running, editing, printing and presenting slides and handouts
1. Networking and Internet;
* Computer networking and internet.
* Electronic mail and world wide web
1. Emerging trends and issues in ICT;
* Identify and integrate emerging trends and issues in ICT
* Challenges posed by emerging trends and issues

**EVIDENCE** **GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Identified and controlled security threats
	2. Detected and protected computer crimes
	3. Applied word processing in office tasks
	4. Designed, prepared work sheet and applied data to the cells in accordance to workplace procedures
	5. Opened electronic mail for office communication as per workplace procedure
	6. Installed internet and World Wide Web for office tasks in accordance with office procedures
	7. Integrated emerging issues in computer ICT applications
	8. Applied laws governing protection of ICT
 |
| 1. Resource Implications
 |  The following resources should be provided:* 1. Access to relevant workplace where assessment can take place
	2. Appropriately simulated environment where assessment can take place
 |
| 1. Methods of Assessment
 | Competency may be assessed through:* 1. Observation
	2. Oral questioning
	3. Written test
	4. Portfolio of Evidence
	5. Interview
	6. Third party report
 |
| 1. Context of Assessment
 | Competency may be assessed:1. On-the-job
2. Off-the –job
3. During Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

**DEMONSTRATE ENTREPRENEURIAL SKILLS**

**UNIT CODE :** ENG/OS/IC/BC/04/6/A

**UNIT DESCRIPTION**

This unit covers the competencies required to demonstrate understanding of entrepreneurship. It involves demonstrating understanding of an entrepreneur, entrepreneurship, and self-employment, identifying entrepreneurship opportunities, creating entrepreneurial awareness, applying entrepreneurial motivation, developing business innovative strategies and developing business plan.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT** | **PERFORMANCE CRITERIA**  |
| 1. Demonstrate understanding of an Entrepreneur
 | 1. Entrepreneurs and Business persons are distinguished as per principles of entrepreneurship
2. ***Types of entrepreneurs*** are identified as per principles of entrepreneurship
3. Ways of becoming an Entrepreneur are identified as per principles of Entrepreneurship
4. ***Characteristics of Entrepreneurs*** are identified as per principles of Entrepreneurship
5. Factors affecting Entrepreneurship development are explored as per principles of Entrepreneurship
 |
| 1. Demonstrate understanding of Entrepreneurship and self-employment
 | 1. Entrepreneurship and self-employment are distinguished as per principles of entrepreneurship
2. Importance of self-employment is analysed based on business procedures and strategies
3. ***Requirements for entry into self-employment*** are identified according to business procedures and strategies
4. Role of an Entrepreneur in business is determined according to business procedures and strategies
5. Contributions of Entrepreneurs to National development are identified as per business procedures and strategies
6. Entrepreneurship culture in Kenya is explored as per business procedures and strategies
7. Born or made Entrepreneurs are distinguished as per entrepreneurial traits
 |
| 1. Identify Entrepreneurship opportunities
 | 1. Sources of business ideas are identified as per business procedures and strategies
2. Business ideas and opportunities are generated as per business procedures and strategies
3. Business life cycle is analysed as per business procedures and strategies
4. Legal aspects of business are identified as per procedures and strategies
5. Product demand is assessed as per market strategies
6. Types of ***business environment*** are identified and evaluated as per business procedures
7. Factors to consider when evaluating business environment are explored based on business procedure and strategies
8. Technology in business is incorporated as per best practice
 |
| 1. Create entrepreneurial awareness
 | 1. ***Forms of businesses*** are explored as per business procedures and strategies
2. Sources of business finance are identified as per business procedures and strategies
3. Factors in selecting source of business finance are identified as per business procedures and strategies
4. ***Governing policies*** on Small Scale Enterprises (SSEs) are determined as per business procedures and strategies
5. Problems of starting and operating SSEs are explored as per business procedures and strategies
 |
| 1. Apply entrepreneurial motivation
 | 1. ***Internal and external motivation*** factors are determined in accordance with motivational theories
2. Self-assessment is carried out as per entrepreneurial orientation
3. Effective communications are carried out in accordance with communication principles
4. Entrepreneurial motivation is applied as per motivational theories
 |
| 1. Develop innovative business strategies
 | 1. Business innovation strategies are determined in accordance with the organization strategies
2. Creativity in business development is demonstrated in accordance with business strategies
3. ***Innovative business strategies*** are developed as per business principles
4. Linkages with other entrepreneurs are created as per best practice
5. ICT is incorporated in business growth and development as per best practice
 |
| 1. Develop Business Plan
 | 1. Identified Business is described as per business procedures and strategies
2. Marketing plan is developed as per business plan format
3. Organizational/Management plan is prepared in accordance with business plan format
4. Production/operation plan in accordance with business plan format
5. Financial plan is prepared in accordance with the business plan format
6. Executive summary is prepared in accordance with business plan format
7. Business plan is presented as per best practice
 |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range**  |
| 1. Types of entrepreneurs may include but not limited to:
 | * Innovators
* Imitators
* Craft
* Opportunistic
* Speculators
 |
| 1. Characteristics of Entrepreneurs may include but not limited to:
 | * Creative
* Innovative
* Planner
* Risk taker
* Networker
* Confident
* Flexible
* Persistent
* Patient
* Independent
* Future oriented
* Goal oriented
 |
| 1. Requirements for entry into self-employment may include but not limited to
 | * Technical skills
* Management skills
* Entrepreneurial skills
* Resources
* Infrastructure
 |
| 1. Internal and external motivation may include but not limited to:
 | * Interest
* Passion
* Freedom
* Prestige
* Rewards
* Punishment
* Enabling environment
* Government policies
 |
| 1. Business environment may include but not limited to:
 | * External
* Internal
* Intermediate
 |
| 1. Forms of businesses may include but not limited to:
 | * Sole proprietorship
* Partnership
* Limited companies
* Cooperatives
 |
| 1. Governing policies may include but not limited to:
 | * Increasing scope for finance
* Promoting cooperation between entrepreneurs and private sector
* Reducing regulatory burden on entrepreneurs
* Developing IT tools for entrepreneurs
 |
| 1. Innovative business strategies may include but not limited to:
 | * New products
* New methods of production
* New markets
* New sources of supplies
* Change in industrialization
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Analytical
* Management
* Problem-solving
* Root-cause analysis
* Communication

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Decision making
* Business communication
* Change management
* Competition
* Risk
* Net working
* Time management
* Leadership
* Factors affecting entrepreneurship development
* Principles of Entrepreneurship
* Features and benefits of common operational practices, e. g., continuous improvement (kaizen), waste elimination,
* Conflict resolution
* Health, safety and environment (HSE) principles and requirements
* Customer care strategies
* Basic financial management
* Business strategic planning
* Impact of change on individuals, groups and industries
* Government and regulatory processes
* Local and international market trends
* Product promotion strategies
* Market and feasibility studies
* Government and regulatory processes
* Local and international business environment
* Relevant developments in other industries
* Regional/ County business expansion strategies

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | 1. Assessment requires evidence that the candidate:
2. Distinguished entrepreneurs and businesspersons correctly
3. Identified ways of becoming an entrepreneur appropriately
4. Explored factors affecting entrepreneurship development appropriately
5. Analysed importance of self-employment accurately
6. Identified requirements for entry into self-employment correctly
7. Identified sources of business ideas correctly
8. GeneratedBusiness ideas and opportunities correctly
9. Analysed business life cycle accurately
10. Identified legal aspects of business correctly
11. Assessed product demand accurately
12. Determined Internal and external motivation factors appropriately
13. Carried out communications effectively
14. Identified sources of business finance correctly
15. Determined Governing policy on small scale enterprise appropriately
16. Explored problems of starting and operating SSEs effectively
17. Developed Marketing, Organizational/Management, Production/Operation and Financial plans correctly
18. Prepared executive summary correctly
19. Determined business innovative strategies appropriately
20. Presented business plan effectively
 |
| 1. Resource Implications
 | The following resources should be provided:1. Access to relevant workplace where assessment can take place
2. Appropriately simulated environment where assessment can take place
 |
| 1. Methods of Assessment
 | 1. Written tests
2. Oral questions
3. Third party report
4. Interviews
5. Portfolio of Evidence
 |
| 1. Context of Assessment
 | Competency may be assessed 1. On-the-job
2. Off-the –job
3. During Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

# DEMONSTRATE EMPLOYABILITY SKILLS

**UNIT CODE:** ENG/OS/IC/BC/05/6/A

**UNIT DESCRIPTON**

This unit covers competencies required to demonstrate employability skills. It involves conducting self-management, demonstrating interpersonal communication, critical safe work habits, leading a workplace team, planning and organizing work, maintaining professional growth and development, demonstrating workplace learning, problem solving skills and managing ethical performance.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Conduct self-management
 | 1. Personal vision, mission and goals are formulated based on potential and in relation to organization objectives
2. Emotional intelligence is demonstrated as per workplace requirements.
3. Individual performance is evaluated and monitored according to the agreed targets.
4. Assertiveness is developed and maintained based on the requirements of the job.
5. Accountability and responsibility for own actions are demonstrated based on workplace instructions.
6. Self-esteem and a positive self-image are developed and maintained based on values.
7. Time management, attendance and punctuality are observed as per the organization policy.
8. Goals are managed as per the organization’s objective
9. Self-strengths and weaknesses are identified based on personal objectives
 |
| 1. Demonstrate interpersonal communication
 | 1. Writing skills are demonstrated as per communication policy
2. Negotiation and persuasion skills are demonstrated as per communication policy
3. Internal and external stakeholders’ needs are identified and interpreted as per the communication policy
4. Communication networks are established based on workplace policy
5. Information is shared as per communication policy
 |
| 1. Demonstrate critical safe work habits
 | * 1. Stress is managed in accordance with workplace policy.
	2. Punctuality and time consciousness is demonstrated in line with workplace policy.
	3. Personal objectives are integrated with organization goals based on organization’s strategic plan.
	4. ***Resources*** are utilized in accordance with workplace policy.
	5. Work priorities are set in accordance to workplace goals and objectives.
	6. Leisure time is recognized and utilized in line with personal objectives.
	7. ***Drugs and substances of abuse*** are identified and avoided based on workplace policy.
	8. HIV and AIDS prevention awareness is demonstrated in line with workplace policy.
	9. Safety consciousness is demonstrated in the workplace based on organization safety policy.
	10. ***Emerging issues*** are identified and dealt with in accordance with organization policy.
 |
| 1. Lead a workplace team
 | 1. Performance targets for the ***team*** are set based on organization’s objectives
2. Duties are assigned in accordance with the organization policy.
3. ***Forms of communication*** in a team are established according to organization’s policy.
4. Team performance is evaluated based on set targets as per workplace policy.
5. Conflicts are resolved between team members in line with organization policy.
6. Gender related issues are identified and mainstreamed in accordance workplace policy.
7. Human rights and fundamental freedoms are identified and respected as Constitution of Kenya 2010.
8. Healthy relationships are developed and maintained in line with workplace.
 |
| 1. Plan and organize work
 | 1. Work plans are prepared based on activities and budget.
2. Assigned tasks are interpreted and expectations identified as per the workplace instructions.
3. Task occupational safety and health requirements are identified and observed regulations.
4. Work resources are identified, mobilized, allocated and utilized based on organization work plans.
5. Work activities are monitored and evaluated in line with work plans and workplace policy.
6. Work plans are reviewed based on target and available resources.
 |
| 1. Maintain professional growth and development
 | * 1. Personal training needs are identified and assessed in line with the requirements of the job.
	2. ***Training and career opportunities*** are identified and utilized based on job requirements.
	3. Resources for training are mobilized and allocated based organizations and individual skills needs.
	4. Licensees and certifications relevant to job and career are obtained and renewed as per policy.
	5. Work priorities and personal commitments are balanced and managed based on requirements of the job and personal objectives.
	6. Recognitions are sought as proof of career advancement in line with professional requirements.
 |
| 1. Demonstrate workplace learning
 | * 1. Learning opportunities are sought and managed based on job requirement and organization policy.
	2. Improvement in performance is demonstrated based on courses attended.
	3. Application of learning is demonstrated in both technical and non-technical aspects based on requirements of the job
	4. Time and effort is invested in learning new skills based on job requirements
	5. Initiative is taken to create more effective and efficient processes and procedures in line with workplace policy.
	6. New systems are developed and maintained in accordance with the requirements of the job.
	7. Awareness of personal role in workplace ***innovation*** is demonstrated based on requirements of the job.
 |
| 1. Demonstrate problem solving skills
 | * 1. Creative, innovative and practical solutions are developed based on the problem
	2. Independence and initiative in identifying and solving problems is demonstrated based on requirements of the job.
	3. Team problems are solved as per the workplace guidelines
	4. Problem solving strategies are applied as per the workplace guidelines
	5. Problems are analyzed and assumptions tested as per the context of data and circumstances
 |
| 1. Manage ethical performance
 | * 1. Policies and guidelines are observed as per the workplace requirements
	2. Self-worth and professionalism is exercised in line with personal goals and organizational policies
	3. Code of conduct is observed as per the workplace requirements
	4. Integrity is demonstrated as per legal requirement
 |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Drug and substance abuse may include but not limited to:
 | Commonly abused1. Alcohol
2. Tobacco
3. Miraa
4. Over-the-counter drugs
5. Cocaine
6. Bhang
7. Glue
 |
| 1. Feedback may include but not limited to:
 | 1. Verbal
2. Written
3. Informal
4. Formal
 |
| 1. Relationships may include but not limited to:
 | 1. Man/Woman
2. Trainer/trainee
3. Employee/employer
4. Client/service provider
5. Husband/wife
6. Boy/girl
7. Parent/child
8. Sibling relationships
 |
| 1. Forms of communication may include but not limited to:
 | 1. Written
2. Visual
3. Verbal
4. Non verbal
5. Formal and informal
 |
| 1. Team may include but not limited to:
 | 1. Small work group
2. Staff in a section/department
3. Inter-agency group
 |
| 1. Personal growth may include but not limited to:
 | 1. Growth in the job
2. Career mobility
3. Gains and exposure the job gives
4. Net workings
5. Benefits that accrue to the individual as a result of noteworthy performance
 |
| 1. Personal objectives may include but not limited to:
 | 1. Long term
2. Short term
3. Broad
4. Specific
 |
| 1. Trainings and career opportunities may includes but not limited to
 | 1. Participation in training programs
2. Serving as Resource Persons in conferences and workshops
 |
| 1. Resource may include may but not limited to:
 | 1. Human
2. Financial
3. Technology
 |
| 1. Innovation may include but not limited to:
 | 1. New ideas
2. Original ideas
3. Different ideas
4. Methods/procedures
5. Processes
6. New tools
 |
| 1. Emerging issues may include but not limited to:
 | 1. Terrorism
2. Social media
3. National cohesion
4. Open offices
 |
| 1. Range of media for learning may include but not limited to:
 | 1. Mentoring
2. peer support and networking
3. IT and courses
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

1. Interpersonal
2. Communication
3. Critical thinking
4. Organizational
5. Negotiation
6. Monitoring
7. Evaluation
8. Record keeping
9. Problem solving
10. Decision Making
11. Resource utilization
12. Resource mobilization

**Required Knowledge**

The individual needs to demonstrate knowledge of:

1. Work values and ethics
2. Company policies
3. Company operations, procedures and standards
4. Occupational Health and safety procedures
5. Fundamental rights at work
6. Workplace communication
7. Concept of time
8. Time management
9. Decision making
10. Types of resources
11. Work planning
12. Organizing work
13. Monitoring and evaluation
14. Record keeping
15. Gender mainstreaming
16. HIV and AIDS
17. Drug and substance abuse
18. Professional growth and development
19. Technology in the workplace
20. Innovation
21. Emerging issues

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Conducted self-management
	2. Demonstrated interpersonal communication
	3. Demonstrated critical safe work habits
	4. Demonstrated the ability to lead a workplace team
	5. Planned and organized work
	6. Maintained professional growth and development
	7. Demonstrated workplace learning
	8. Demonstrated problem solving skills
	9. Demonstrated the ability to manage performance ethically
 |
| 1. Resource Implications
 | The following resources should be provided:1. Access to relevant workplace where assessment can take place
2. Appropriately simulated environment where assessment can take place
 |
| 1. Methods of Assessment
 | Competency in this unit may be assessed through: 1. Observation
2. Oral questioning
3. Written test
4. Portfolio of Evidence
5. Interview
6. Third party report
 |
| 1. Context of Assessment
 | Competency may be assessed:1. On-the-job
2. Off-the –job
3. During Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

# DEMONSTRATE ENVIRONMENTAL LITERACY

**UNIT CODE:** ENG/OS/IC/BC/06/6/A

**UNIT DESCRIPTION**

This unit specifies the competencies required to demonstrate environmental literacy. It involves, controlling environmental hazard and environmental pollution, demonstrating sustainable resource use, evaluating current practices in relation to resource usage, identifying environmental legislations/conventions for environmental concerns, implementing specific environmental programs, monitoring activities on environmental protection/Programs , analyzing resource use and developing resource conservation plans

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Control environmental hazard
 | 1. Storage methods for environmentally hazardous materials are strictly followed according to environmental regulations and OSHS.
2. Disposal methods of hazardous wastes are followed according to environmental regulations and OSHS.
3. ***PPE*** is used according to OSHS.
 |
| 1. Control environmental Pollution
 | * 1. Environmental pollution ***control measures*** are implemented in accordance with international protocols.
	2. Procedures for solid waste management are observed according Environmental Management and Coordination Act 1999
	3. Methods for minimizing noise pollution is complied with based on Noise and Excessive Vibration Pollution and Control Regulations, 2009
 |
| 1. Demonstrate sustainable resource use
 | * 1. Methods for minimizing wastage are complied with based on organizational waste management guide
	2. Waste management procedures are employed following principles of 3Rs (Reduce, Reuse, Recycle)
	3. Methods for economizing and reducing resource consumption are practiced as per the Constitution of Kenya 2010 Article 69 .
 |
| 1. Evaluate current practices in relation to resource usage
 | * 1. Information on resource efficiency systems and procedures are collected and provided as per work groups/sector
	2. Current resource usage is measured and recorded as per work group
	3. Current purchasing strategies are analyzed and recorded according to industry procedures.
	4. Current work processes to access information and data is analyzed following enterprise protocol.
 |
| 1. Identify environmental legislations/conventions for environmental concerns
 | 1. Environmental legislations/conventions and local ordinances are identified according to the different environmental aspects/impact
2. Industrial standard/environmental practices are described according to the different environmental concerns
 |
| 1. Implement specific environmental programs
 | 1. Programs/Activities are identified according to organizations policies and guidelines.
2. Individual roles/responsibilities are determined and performed based on the activities identified.
3. Problems/constraints encountered are resolved in accordance with organizations’ policies and guidelines
4. Stakeholders are consulted based on company guidelines
 |
| 1. Monitor activities on Environmental protection/Programs
 | 1. Activities are periodically monitored and Evaluated according to the objectives of the environmental program
2. Feedback from stakeholders are gathered and considered in Proposing enhancements to the program based on consultations
3. Data gathered are analyzed based on Evaluation requirements
4. Recommendations are submitted based on the findings
5. Management support systems are set/established to sustain and enhance the program
6. Environmental incidents are monitored and reported to
7. concerned/proper authorities
 |
| 1. Analyze resource use
 | 1. All resource consuming processes are Identified as per the organizational work plan
2. Quantity and nature of resource consumed is determined based on processes
3. Resource flow is analyzed as per different parts of the process.
4. Wastes are classified according to NEMA regulations on waste management.
 |
| 1. Develop resource Conservation plans
 | 9.1. Efficiency of use/conversion of resources is determined according to industry protocol.9.2. Causes of low efficiency of use of resources are Determined based on industry protocol.9.3. Plans for increasing the efficiency of resource use are developed based on findings. |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. PPE may include but not limited to
 | * + Mask
	+ Gloves
	+ Goggles
	+ Safety hat
	+ Overall
* Hearing protector
 |
| 1. Control measures may include but not limited to
 | * Methods for minimizing or stopping spread and ingestion of airborne particles
* Methods for minimizing or stopping spread and ingestion of gases and fumes
* Methods for minimizing or stopping spread and ingestion of liquid wastes
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Measuring
* Recording
* Analytical
* Monitoring
* Communication
* Writing

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* PPEs
* Environmental regulations
* OSHS
* Pollution
* Waste management
* Principle of 3Rs
* Types of resources
* Techniques in measuring current usage of resources
* Environmental hazards
* Regulatory requirements

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Controlled environmental hazard
	2. Controlled environmental pollution
	3. Demonstrated sustainable resource use
	4. Evaluated current practices in relation to resource usage
	5. Demonstrated knowledge of environmental legislations and local ordinances according to the different environmental issues /concerns.
	6. Described industrial standard environmental practices according to the different environmental issues/concerns.
	7. Resolved problems/ constraints encountered based on management standard procedures
	8. Implemented and monitored environmental practices on a periodic basis as per company guidelines
	9. Recommended solutions for the improvement of the program
	10. Monitored and reported to proper authorities any environmental incidents
 |
| 1. Resource Implications
 | The following resources should be provided:* 1. Workplace with storage facilities
	2. Tools, materials and equipment relevant to the tasks (e.g. Cleaning tools, cleaning materials, trash bags)
	3. PPE, manuals and references
	4. Legislation, policies, procedures, protocols and local ordinances relating to environmental protection
	5. Case studies/scenarios relating to environmental Protection
 |
| 1. Methods of Assessment
 | Competency in this unit may be assessed through:* 1. Observation
	2. Oral questioning
	3. Written test
	4. Portfolio of Evidence
	5. Interview
	6. Third party report
 |
| 1. Context of Assessment
 | Competency may be assessed 1. On-the-job
2. Off-the –job
3. During Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

# DEMONSTRATE OCCUPATIONAL SAFETY AND HEALTH PRACTICES

**UNIT CODE:** ENG/OS/IC/BC/07/6/A

**UNIT DESCRIPTION**

This unit specifies the competencies required to demonstrate occupational health and safety practices. It involves identifying workplace hazards and risks, identifying and implementing appropriate control measures to hazards and risks and implementing OSH programs, procedures and policies/guidelines.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Identify workplace hazards and risk
 | 1.1 ***Hazards*** in the workplace are identified ***based their indicators*** 1.2 Risks and hazards are evaluated based on legal requirements.1.3 ***OSH concerns*** raised by workers are addressed as per legal requirements.  |
| 1. Control OSH hazards
 | 2.1 Hazard prevention ***and control measures*** are implemented as per legal requirement.2.2 Risk assessment is conductedand a risk matrix developed based on likely impact.2.3 ***Contingency measures***, including ***emergency procedures*** during workplace ***incidents and emergencies*** are recognized and established in accordance with organization procedures. |
| 1. Implement OSH programs
 | 3.1 Company OSH program are identified, evaluated and reviewed based on legal requirements.3.2 Company OSH programs are implemented as per legal requirements.3.3 Workers are capacity built on OSH standards and procedures as per legal requirements3.4 ***OSH-related records*** are maintained as per legal requirements. |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Hazards may include but not limited to:
 | * Physical hazards – impact, illumination, pressure, noise,
* vibration, extreme temperature, radiation
* Biological hazards- bacteria, viruses, plants, parasites, mites, molds, fungi, insects
* Chemical hazards – dusts, fibers, mists, fumes, smoke, gasses, vapors
* Ergonomics
* Psychological factors – over exertion/ excessive force,

awkward/static positions, fatigue, direct pressure,* varying metabolic cycles
* Physiological factors – monotony, personal relationship, work out cycle
* Safety hazards (unsafe workplace condition) –confined space, excavations, falling objects, gas leaks, electrical, poor storage of materials and waste, spillage, waste and debris
* Unsafe workers’ act (Smoking in off-limited areas, Substance and alcohol abuse at work)
 |
| 1. Indicators may include but not limited to:
 | * Increased of incidents of accidents, injuries
* Increased occurrence of sickness or health complaints/ symptoms
* Common complaints of workers related to OSH
* High absenteeism for work-related reasons
 |
| 1. OSH concerns may include but not limited to:
 | * Workers’ experience/observance on presence of work hazards
* Unsafe/unhealthy administrative arrangements (prolonged work hours, no break time, constant overtime, scheduling of tasks)
* Reasons for compliance/non-compliance to use of PPEs or other OSH procedures/policies/guidelines
 |
| 1. Safety gears /PPE (Personal Protective Equipment) may include but not limited to:
 | * Arm/Hand guard, gloves
* Eye protection (goggles, shield)
* Hearing protection (ear muffs, ear plugs)
* Hair Net/cap/bonnet
* Hard hat
* Face protection (mask, shield)
* Apron/Gown/coverall/jump suit
* Anti-static suits
* High-visibility reflective vest
 |
| 1. Appropriate risk controls

may include but not limited to: | * Appropriate risk controls in order of impact are as follows:
* Eliminate the hazard altogether (i.e., get rid of the dangerous machine)
* Isolate the hazard from anyone who could be harmed (i.e., keep the machine in a closed room and operate it remotely; barricade an unsafe area off)
* Substitute the hazard with a safer alternative (i.e., replace the machine with a safer one)
* Use administrative controls to reduce the risk (i.e., train workers how to use equipment safely; train workers about the risks of harassment; issue signage)
* Use engineering controls to reduce the risk (i.e., attach guards to the machine to protect users)
* Use personal protective equipment (i.e., wear
* gloves and goggles when using the machine)
 |
| 1. Contingency measures may include but not limited to:
 | * Evacuation
* Isolation
* Decontamination
* (Calling designed) emergency personnel
 |
| 1. Incidents and emergencies may include but not limited to:
 | * Chemical spills
* Equipment/vehicle accidents
* Explosion
* Fire
* Gas leak
* Injury to personnel
* Structural collapse
* Toxic and/or flammable vapors emission.
 |
| 1. OSH-related Records may include but not limited to:
 | * Medical/Health records
* Incident/accident reports
* Sickness notifications/sick leave application
* OSH-related trainings obtained
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Interpersonal
* Presentation
* Risk assessment
* Evaluation
* Critical thinking
* Problem solving
* Negotiation

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* General OSH Principles
* Occupational hazards/risks recognition
* OSH organizations providing services on OSH evaluation and/or work environment measurements (WEM)
* National OSH regulations; company OSH policies and protocols
* Systematic gathering of OSH issues and concerns
* General OSH principles
* National OSH regulations
* Company OSH and recording protocols, procedures and policies/guidelines
* Training and/or counseling methodologies and strategies

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:1. Identified hazards in the workplace based their indicators
2. Evaluated workplace hazards based on legal requirements.
3. Addressed OSH concerns raised by workers as per legal requirements.
4. Implemented hazard prevention and control measures as per legal requirement.
5. Conducted risk assessment as per legal requirement.
6. Developed risk matrix based on likely impact.
7. Recognized and established contingency measures in accordance with organization procedures.
8. Identified, evaluated and reviewed company OSH program based on legal requirements.
9. Implemented company OSH programs as per legal requirements.
10. Capacity built workers on OSH standards and procedures as per legal requirements
11. Maintained OSH-related records as per legal requirements.
 |
| 1. Resource Implications
 | The following resources should be provided:1. Access to relevant workplace where assessment can take place
2. Appropriately simulated environment where assessment can take place
 |
| 1. Methods of Assessment
 | Competency in this unit may be assessed through: 1. Observation
2. Oral questioning
3. Written test
4. Portfolio of Evidence
5. Interview
6. Third party report
 |
| 1. Context of Assessment
 | Competency may be assessed:1. On-the-job
2. Off-the –job
3. During Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

#

# COMMON UNITS OF COMPETENCY

## **APPLY ENGINEERING MATHEMATICS**

**UNIT CODE: ENG/OS/IC/CC/02/6/A**

**UNIT DESCRIPTION**

This unit describes the competencies required by a Mechatronics Engineering technician to apply a wide range of engineering mathematics in their work. This includes: applying algebraic functions, trigonometry and hyperbolic functions, complex numbers, coordinate geometry, carrying out binomial expansion, calculus, ordinary differential equations, Laplace transforms, power series, Statistics, Fourier series, Vector theory, Matrix, Numerical methods, probability, commercial calculations, estimations, measurements and calculations of quantities in solving problems.

|  |  |
| --- | --- |
| **ELEMENTS AND PERFORMANCE CRITERIAELEMENT** These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range.*** |
| * 1. Apply Algebra
 | 1. Calculations involving Indices are performed as per the concept
2. Calculations involving Logarithms are performed as per the concept
3. Scientific calculator is used in solving mathematical problems in line with manufacturer’s manual
4. Simultaneous equations are performed as per the rules
5. Quadratic equations are calculated as per the concept
6. Arithmetic and geometric progression problems are solved
 |
| * 1. Apply Trigonometry and hyperbolic functions
 | 1. Calculations are performed using trigonometric rules
2. Calculations are performed using ***hyperbolic functions***
 |
| * 1. Apply complex numbers
 | * 1. Complex numbers are represented using Argand diagrams
	2. Operations involving complex numbers are performed
	3. Calculations involving complex numbers are performed using De Moivre’s theorem
 |
| 1. Apply Coordinate Geometry
 | * 1. Polar equations are calculated using coordinate geometry
	2. Graphs of given polar equations are drawn using the Cartesian plane
	3. Normal and tangents are determined using coordinate geometry
	4. Loci of points are determined for given mechanism
 |
| 1. Carry out Binomial Expansion
 | * 1. Roots of numbers are determined using binomial theorem
	2. Errors of small changes are determined using binomial theorem
	3. Power series are derived through Binomial expansion
 |
| 1. Apply Calculus
 | * 1. Derivatives of functions are determined using Differentiation
	2. Derivatives of hyperbolic functions are determined using Differentiation
	3. Derivatives of inverse trigonometric functions are determined using Differentiation
	4. Rate of change and small change are determined using Differentiation.
	5. Calculation involving stationery points of functions of two variables are performed using differentiation.
	6. Integrals of algebraic functions are determined using integration
	7. Integrals of trigonometric functions are determined using integration
	8. Integrals of logarithmic functions are determined using integration
	9. Integrals of hyperbolic and inverse functions are determined using integration
 |
| 1. Solve Ordinary differential equations
 | * 1. First order and second order differential equations are formed.
	2. First order and second order differential equations are solved using the method of undetermined coefficients
	3. First order and second order differential equations are solved from given boundary conditions
 |
| 1. Apply Laplace transforms
 | * 1. Laplace transforms are solved using initial and final value theorems
	2. Inverse Laplace transforms are solved using partial fractions
	3. Differential equations are solved using Laplace transforms
 |
| 1. Apply Power Series
 | * 1. Power series are obtained using Taylor’s Theorem
	2. Power series are obtained using Maclaurin’s theorem
 |
| 1. Apply Statistics
 | 1. Identification, Collection and Organization of data is performed
2. Interpretation, analysis and presentation of data in appropriate format is performed
3. Mean, median, mode and Standard deviation are obtained from given data
 |
| 1. Apply Fourier Series
 | * 1. Fourier series coefficients are obtained using Fourier series techniques
	2. Fourier series for 2π to T is are obtained using Fourier series techniques
	3. Fourier series for odd and even functions are obtained using Fourier series techniques
	4. Harmonic analysis is performed using numerical methods
 |
| 12.Apply Vector theory | * 1. Calculations involving vector algebra, dot and cross products using vector theory
	2. Gradient, Divergence and Curl are obtained
	3. Vector calculations are performed using Green’s theorem
	4. Vector calculations are performed using Stoke’s theorem
	5. Conservative vector fields and line and surface integrals are obtained using Gauss’s theorem
 |
| 1. Apply Matrix
 | * 1. Determinant and inverse of 3x3 matrix are obtained
	2. Solutions of simultaneous equations are obtained
	3. Calculation involving Eigen values and Eigen vectors are performed
 |
| 1. Apply Numerical methods
 | * 1. Roots of polynomials are obtained using iterative numerical methods
	2. Interpolation and extrapolation are performed using numerical methods
 |
| 1. Apply concepts of probability for work
 | * 1. Calculations are performed based on Laws of probability
	2. Calculation involving probability distributions, mathematical expectation sampling distributions are performed
	3. Probability events are determined from dependent, independent and mutually exclusive
	4. Counting is done using permutation, combination, tree diagrams and Venn diagrams techniques
 |
| 1. Perform commercial calculations
 | * 1. Exchange rate calculations are done using devaluation and revaluation
	2. Sales, stock turnover and profit and loss are determined
	3. Incomes, salaries and wages are calculated
 |
| 1. Perform estimations, measurements and calculations of quantities
 | * 1. Measurement information in workplace is extracted and interpreted
	2. Appropriate workplace measuring tools and equipment are identified and selected
	3. Conversions are performed between units of measurement
	4. Measurements are estimated and taken
	5. Length, width, height, perimeter, area and angles of ***figures*** are calculated
	6. Volume and surface area of figures are calculated
	7. Information is recorded using mathematical language and symbols appropriate for the task
 |

 **RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range**  |
| 1. Hyperbolic functions may include but not limited to:
 | * + Sinh x
	+ Cosh x
	+ Cosec x
	+ Coth x
	+ Tanh x
	+ Sech x
 |
| 1. Figures may include but not limited to:
 | * + Triangles
	+ Squares
	+ Rectangles
	+ Circles
	+ Spheres
	+ Cylinders
	+ Cubes
	+ Polygons
	+ Cuboids
	+ Pyramids
 |
| 1. Quantities may include but not limited to:
 | * + Weight,
	+ Mass
	+ Area
	+ Volume
	+ Length
	+ Width
	+ Depth
	+ Perimeter
 |

**REQUIRED SKILLS AND KNOWLEDGE**

 This section describes the skills and knowledge required for this unit of competency.

 **Required Skills**

 The individual needs to demonstrate the following skills:

* Applying fundamental operations (addition, subtraction, division, multiplication)
* Using and applying mathematical formulas
* Logical thinking
* Problem solving
* Applying statistics
* Drawing graphs
* Using different measuring tools

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Fundamental operations (addition, subtraction, division, multiplication)
* Calculating area and volume
* Types and purpose of measuring instruments
* Units of measurement and abbreviations
* Rounding techniques
* Types of fractions
* Types of tables and graphs
* Presentation of data in tables and graphs
* Vector operations
* Matrix operations

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills, knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency
 | Assessment requires evidence that the candidate: * 1. Applied Trigonometry and hyperbolic functions
	2. Applied complex numbers
	3. Determined angles and length in triangles
	4. Applied Calculus
	5. Solved Ordinary differential equations
	6. Applied Laplace transforms
	7. Applied Power Series
	8. Applied Fourier Series
	9. Applied Vector theory
	10. Applied Matrix

1.11 Identified and selected measuring equipment 1.12 Collected, Analyzed and presented data1.13 Applied Numerical methods |
| 1. Resource Implications
 | The following resources should be provided:1. Access to relevant workplace where assessment can take place
2. Appropriately simulated environment where assessment can take place
 |
| 1. Methods of Assessment
 | Competency in this unit may be assessed through: * 1. Direct Observation
	2. Demonstration with Oral Questioning
	3. Written tests
 |
| 1. Context of Assessment
 |  Competency may be assessed 1. Off the job
2. on the job
3. During industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

#

# PERFORM WORKSHOP PROCESS

**UNIT CODE:** ENG/OS/IC/CC/02/6/A

**UNIT DESCRIPTION**

This unit specifies the competencies required to perform workshop processes. It involves applying workshop safety, using workshop tools, instruments and equipments, preparing workshop tools and instruments for an electrical installation practical, storing electrical tools and materials after practicals, troubleshooting and repairing/ replacing workshop tools and equipments

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  | **PERFORMANCE CRITERIA*****(Bold and italicized terms are elaborated in the Range)*** |
| --- | --- |
| 1. Apply workshop safety | 1.1 Proper use of PPE is adhered to as per standard operating procedure1.2 Workshop rules are followed as per standard operating procedure1.3 Proper use of safety equipment is followed as per the manufacturers recommendations1.4 First Aid procedures are adhered to |
| 1. Use workshop tools, Instruments and equipment
 | * 1. ***Workshop tools***, Instruments and equipment are Identified
	2. Tools, Instruments and equipment are used as per the manufactures manuals
	3. Calibration of workshop instruments are performed as per the standard operating procedure
	4. Proper handling of workshop tools, Instruments and equipment should be followed
	5. Care and Maintenance of workshop tools, Instruments and equipment should be adhered too
 |
| 1. Prepare workshop tools and instruments for an Electrical installation practical
 | * 1. List of required tools and instruments are prepared
	2. Issuing of required tools and instruments is performed
	3. Confirmation of the issued tools and instruments is performed
	4. Functioning of the issued tools and instruments is checked in line with the standard operating procedure
	5. Sharpening of the cutting tools is performed
 |
| 1. Prepare workshop for an Electrical practical
 | * 1. Practical working section is arranged as per the number of practicals to be carried out.
	2. Power supply availability in every practical section is confirmed as per the practical to be carried out
	3. Tools and materials required are supplied as per the practical to be carried out.
 |
| 1. Store electrical tools and materials after practicals
 | * 1. Tools are checked against the issuing list after practicals
	2. Tools are stored out as per their standard operating procedure
	3. Tools are cleaned as per the workshop standard operating procedure
	4. Waste materials are disposed as per the EHS
	5. Tools are stored in their respective sections as per the workshop procedures
 |
| 1. Troubleshoot and repair/replace workshop tools and equipment
 | * 1. Faulty tools are identified as per their expected functioning
	2. Faulty component is diagnosed as per the fault diagnosis procedures
	3. Repair/Replace faulty components as per the expected functioning
	4. Repaired/Replaced tool are tested as per the expected functioning.
 |

**RANGE**

| **Variable** | **Range** |
| --- | --- |
| 1. Workshop toolsmay include but not limited to:
 | * + Pliers
	+ Hacksaws
	+ Hammer
	+ Spirit levels
	+ Phase Tester
	+ Side cutters
 |

**REQUIRED KNOWLEDGE AND UNDERSTANDING**

***The individual needs to demonstrate knowledge and understanding of:***

**Organisational and legislative requirements including:**

* The manufacturer's manual about the operation of various workshop tools and instruments
* The legal and statutory requirements relating to electrical Workshop operation activities.
* Workplace procedures relevant to:
* Health and safety
* The environment (including waste disposal);
* 1Appropriate personal and protective equipment;
* Appropriate use of service manuals
* Workplace procedures for:
* Fault identification and diagnosis
* Appropriate use of tools and equipment;
* Repairing, modifying or replacing defective parts or components.
* Reporting of technical challenges
* The importance of documenting workshop practical activities and information.
* The importance of working within agreed timelines and sharing progress reports.
* The importance of reporting anticipated delays to relevant parties promptly.
* The manufacturer's manual about the operation of various workshop tools and instruments
* The legal and statutory requirements relating to electrical Workshop operation activities.
* Workplace procedures relevant to:
* Health and safety
* The environment (including waste disposal);
* Appropriate personal and protective equipment;
* Appropriate use of service manuals
* Workplace procedures for:
* Fault identification and diagnosis
* Appropriate use of tools and equipment;
* Repairing, modifying or replacing defective parts or components.
* Reporting of technical challenges
* The importance of documenting workshop practical activities and information.
* The importance of working within agreed timelines and sharing progress reports.
* The importance of reporting anticipated delays to relevant parties promptly.
* The use of technical information including:
* How to find, interpret and use sources of technical information for workshop practical activities
* The importance of using the correct sources of technical information.
* The purpose of and how to use identification codes.

**FOUNDATION SKILLS**

The individual needs to demonstrate the following foundation skills:

* Communications (verbal and written);
* Proficient in ICT;
* Time management;
* Analytical
* Faults troubleshooting;
* Problem solving;
* Planning;
* Decision making;
* First aid;
* Report writing;

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge and understanding and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:* 1. Adhered to the proper use of PPE
	2. Observed the workshop rules
	3. Performed the First Aid procedures in the workshop
	4. Observed workshop procedures in the storage of tools
	5. Safely used testing equipment and tools
	6. Observed EHS in the waste disposal
	7. Properly demonstrated care and maintenance of workshop tools
	8. Obtained, recorded and interpreted test results
	9. Identified faulty tools and instruments
	10. Repaired/Replaced faulty tools
 |
| 2. Resource Implications | The following resources should be provided:1. Access to relevant workplace where assessment can take place
2. Appropriately simulated environment where assessment can take place
 |
| 3. Methods of Assessment | Competency may be assessed through:3.1 Oral test3.2 Observation 3.3 Practical demonstration  |
| 4. Context of Assessment | Competency may be assessed 1. Off the job
2. on the job
3. During industrial attachment
 |
| 5. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

# APPLY ELECTRICAL PRINCIPLES

**UNIT CODE:** ENG/OS/IC/CC/03/6/A

**UNIT DESCRIPTION**

This unit describes the competencies required to apply Electrical principles skills in their work. It involves using the concept of basic electrical quantities, using the concepts of D.C and A.C circuits in electrical installation, using of basic electrical machine, using of power factor in electrical installation, using of earthing in electrical installations, using of earthing in electrical installations and applying lightning protection measures, applying electromagnetic field theory, applying electro dynamics, applying energy and momentum in electromagnetic field, applying transient in electrical circuit analyzing, using two port networks and demonstrate understanding of refrigeration and air conditioning

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT** These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range.*** |
| --- | --- |
| 1. Use the concept of basic Electrical quantities | * 1. Basic ***SI unit***s in Electrical are identified
	2. ***Quantitie***s of Charge, force, work and power are identified
	3. Perform calculations involving Ohm’s law i.e Current, Resistance and voltage
	4. Calculations involving various electrical quantities are performed
 |
| 2. Use the concepts of D.C and A.C circuits in electrical installation | * 1. Calculations involving parallel and series circuits are performed
	2. Calculations involving DC and AC Network theorems are performed. E.g. Kirchoff’s laws, Superposition, Thevinin’s, Norton’s
 |
| 3. Use of basic electrical machine | * 1. Types of various electrical machines are identified
	2. Calculations involving single phase and three phase AC and DC Motors are performed
	3. Calculations involving single and three phase AC and DC transformers are performed
	4. Calculations involving single and three phase generators are performed
	5. Special machines are identified
	6. Calculations involving special machines are performed
	7. Calculations involving Electric Drives are performed
 |
| 4. Use of power factor in electrical installation | * 1. Power triangle is identified i.e. Active, Apparent and reactive power
	2. The use of power factor is performed
	3. Calculations involving power factor correction is performed
	4. Methods of power factor correction are applied
 |
| 5. Use of earthing in Electrical installations | 5.1 Earthing types are identified5.2 Earthing points on Electrical installation are identified5.3 Calculation involved in determining the earthing type is performed5.4 Test on an earthing system is performed in line with the IEE regulations |
| 6. Apply lightning protection measures | * 1. Types of lightening strokes are identified
	2. Components of lightening protection system are identified
	3. Test to be carried out in lightening protection system are established
	4. Application of lightening protection system is determined
 |
| 7. Apply Electromagnetic Field Theory | * 1. Electromagnetic radiation sources are identified
	2. Detectors of Electromagnetic radiations are determined
	3. Electromagnetic waves are applied
	4. Electromagnetics Laws are Identified
	5. Behaviors and effects of Electromagnetic waves are established
 |
| 8. Apply Electrodynamics | * 1. Electrostatics terms are identified

8.2 Magnetostatics terms are identified8.3 Electrodynamics laws are identified |
| 9. Apply Energy and Momentum in Electromagnetic field | * 1. Energy conservation theorem is identified

9.2 Electromagnetic Energy flow is determined |
| 10. Apply transients in Electrical Circuit Analysis | * 1. Growth and decay in R-L-C circuits are determined

10.2 Calculations involving Growth and decay in R-L-C are performed |
| 11. Use Two Port networks | * 1. Basic passive networks are performed
	2. Characteristic impedance is determined
	3. Types of transmission lines and their applications are performed
 |
| 12. Demonstrate understanding of Refrigeration and Air conditioning | * 1. Use of Refrigeration and Air conditioning is demonstrated
	2. Installation of the Refrigeration and Air conditioning system is simulated
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range**  |
| 1. SI unit may include but not limited to:
 | * + Power – Watts (W)
	+ Current – Amperes (A)
	+ Resistance – Ohms(Ω)
	+ Voltage – Volts (V)
 |
| 1. Quantities may include but not limited to:
 | * + Charge
	+ Force
	+ Work
	+ Power
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Apply basic Electrical formulas
* Use of basic Electrical instruments
* Perform various unit conversions of Electrical quantities
* Electrical earthing
* Lightening arrestors
* Power factor correction
* Logical thinking
* Problem solving
* Applying statistics
* Drawing graphs
* Using different measuring tools

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Electrical power calculations
* Various laws in Electrical engineering
* Electrical formulas
* Power triangle
* SI units of various electrical parameters
* Earthing testing
* Lightening arrestor testing
* Selecting the correct type of electrical machines for various uses
* Types and purpose of measuring instruments
* Units of measurement and abbreviations

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency | Assessment requires evidence that the candidate: * 1. Applied the correct SI units of Electrical quantities
	2. Stated, Calculate and relates the quantities in Ohm’s law
	3. Identified the components of an earthing system
	4. Stated and apply various laws in Electrical system
	5. Differentiated between AC and DC network
	6. Applied correct formulas in the calculation of AC and DC machines
	7. Used power triangle in calculating power factor
	8. Applied various methods in power factor correction
	9. Identified types of lightening arrestors and their applications
 |
| 2. Resource Implications | The following resources should be provided:1. Access to relevant workplace where assessment can take place
2. Appropriately simulated environment where assessment can take place
 |
| 3. Methods of Assessment | Competency in this unit may be assessed through: 3.1 Direct Observation3.2 Demonstration with Oral Questioning 3.3 Written tests |
| 1. 4. Context of Assessment
 |  Competency may be assessed 1. Off the job
2. on the job
3. During industrial attachment
 |
| 1. 5. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

# PREPARE AND INTERPRET TECHNICAL DRAWINGS

**UNIT CODE:** ENG/OS/IC/CC/04/6/A

**UNIT DESCRIPTION**

This unit covers the competencies required to prepare and interpret technical drawings. It involves selecting, using and maintaining drawing equipment and materials, producing plain geometry drawings, solid geometry drawings, pictorial and orthographic drawings and applying Computer Aided Design (CAD) packages.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  | **PERFORMANCE CRITERIA*****(Bold and italicized terms are elaborated in the Range)*** |
| --- | --- |
| 1. Use and maintain drawing equipment and materials | 1.1 ***Drawing equipment*** are identified and gathered according to task requirements1.2 ***Drawing materials*** are identified and gathered according to task requirements 1.3 Drawing equipment are used and maintained as per manufacturer’s instructions1.4 Drawing materials are used as per workplace procedures1.5 Waste materials are disposed in accordance with workplace procedures and ***environmental legislations***1.6 ***Personal Protective Equipment*** is used according to occupational safety and health regulations |
| 2. Produce plane geometry drawings | * 1. Different types of lines used in drawing and their meanings are identified according to standard drawing conventions
	2. Different types of ***geometric forms*** are constructed according to standard conventions
	3. Different types of angles are constructed according to principles of trigonometry
	4. Different types of angles are measured using appropriate measuring tools
	5. Angles are bisected according to standard conventions

2.10 Freehand sketching of different types of geometric forms, tools, equipment, diagrams is conducted |
| 3. Produce solid geometry drawings | 3.1 Drawings of patterns are interpreted according to standard conventions3.2 Patterns are developed in accordance with standard conventions  |
| 4. Produce orthographic and pictorial drawings  | 4.1 Symbols and abbreviations are identified and their meaning interpreted according to standard drawing conventions4.2 First and third angle orthographic drawings are interpreted and produced in accordance with the standard conventions4.3 Orthographic elevations are dimensioned in accordance with standard conventions4.4 Isometric drawings are interpreted and produced in accordance with standard conventions 4.5 Assembly drawing is produced and interpreted in line with the operating standards |
| 5. Produce electrical drawings  | 5.1 Electrical symbols and abbreviations are identified and their meaning interpreted according to BS 39395.2 ***Electrical drawings*** are produced in accordance with BS 3939 |
| 6. Apply CAD packages | 6.1 CAD packages are selected according to task requirements6.2 CAD packages are applied in production of electrical drawings  |

**RANGE**

| **Variable** | **Range** |
| --- | --- |
| 1. Drawing equipment may include but is not limited to:
 | * Drawing boards
* T and set squares
* drawing sets
* computers with CAD packages
 |
| 1. Drawing materials may include but is not limited to:
 | * Drawing papers
* Pencils
* Erasers
* masking tapes
* paper clips
 |
| 1. Environmental legislations may include but is not limited to:
 | * EMCA 1999
 |
| 1. Personal Protective Equipment may include but is not limited to:
 | * Dust coats
* closed leather shoes
 |
| 1. Geometric forms may include but is not limited to:
 | * Circles
* Triangles
* Rectangles
* Parallelogram
* Polygons
* Pyramids
* Conic sections
* Prisms
* Loci
 |
| 1. Standard conventions may include but is not limited to:
 | * Anatomy of engineering drawing (title block, coordinate grid system, revision block, notes and legends)
* Drawing scale (paper size and drawing symbols)
* International drawing standards
 |
| 1. Electrical drawings may include but is not limited to:
 | * Block
* Schematic
* Circuit
* line
* wiring diagrams
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required skills**

The individual needs to demonstrate the following skills:

* Critical thinking
* Drawing
* Interpretation
* Drawing equipment handling
* Analysis and synthesis
* Communication
* Inter personal

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Drawing equipment and materials
* Freehand sketching
* Lettering
* Geometrical constructions
* Types of drawings
* Types of lines
* Isometric drawing conventions, features, characteristics, components
* Orthographic drawing conventions, features, characteristics, components
* Sketches and drawings of simple patterns

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge and understanding and range.

|  |  |
| --- | --- |
| 1.Critical Aspects of Competency | Assessment requires evidence that the candidate:* 1. Applied and adhered to safety procedures
	2. Cared and maintained drawing equipment
	3. Interpreted circuit, assembly and lay out diagrams
	4. Applied appropriate technical standards, used proper tools and equipment for a given task
	5. Produced sketches and drawings
	6. Applied CAD packages in production of drawings
 |
| 2.Resource Implications | The following resources should be provided:1. Access to relevant workplace where assessment can take place
2. Appropriately simulated environment where assessment can take place
 |
| 3.Methods of Assessment | Competency may be assessed through:* 1. Practical tests
	2. Observation
 |
| 4.Context of Assessment | Competency may be assessed 1. Off the job
2. on the job
3. During industrial attachment
 |
| 5.Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

# CORE UNITS OF COMPETENCY

MANAGE ELECTRICAL MOTOR CONTROLS SYSTEMS

UNIT CODE: ENG/OS/IC/CR/01/6/A

UNIT DESCRIPTION

This unit articulates the competencies required to become proficient in the safe installation, repair, maintenance, and troubleshooting of motor control circuits in industrial/manufacturing and automated settings. It involves the learner to design, install and test common control circuits (i.e. Forward/Reversing, Jogging, soft start, single and 3Φ).

ELEMENTS AND PERFORMANCE CRITERIA

|  |  |
| --- | --- |
| ELEMENTThese describe the key outcomes which make up workplace function. | PERFORMANCE CRITERIAThese are assessable statements which specify the required level of performance for each of the elements.Bold and italicized terms are elaborated in the Range |
| 1. Install motor control equipment
 | 1.1 Electrical drawings are interpreted in accordance with electrical and electronics regulations.1.2 Components are identified and selected for installation in accordance with the drawing.1.3 Tools are selected for installation as per the circuit components and parts.1.4 Electrical control system is installed as per the design.1.5 Electrical control circuit is energized and tested in accordance with the intended design drawings. |
| 1. Design and develop motor control systems
 | 2.1 Electrical drawing is prepared in accordance with electrical and electronics’ regulations.2.2 Components values and ratings are calculated and determined in accordance with standard electrical design principles.2.3 Motor control prototype is built as per the drawing in accordance with electrical and electronic regulations2.4 Motor control prototype is simulated and operational response and behavior analyzed and compared with set objectives.2.5 Motor control prototype test data is developed and documented in accordance with workplace procedures. |
| 1. Troubleshoot and repair electrical motor control systems
 | 3.1 Motor control diagnostic/troubleshooting tools are selected in accordance with task requirements.3.2 Motor control faulty components are identified, replaced or repaired in accordance with manufacturers’ specifications.3.3 Repaired/replaced components are inspected.3.4 Motor control system functional test(s) are carried out on motor controls.3.5 Motor control Job rectification card(s) are filled out. |
| 1. Maintain motor control systems
 | 4.1 Maintenance schedule is prepared according to workplace procedures. 4.1 Maintain motor control maintenance procedure manuals are acquired and materials/tools/equipment list prepared and selected in accordance with task requirements. 4.3 Motor control system is inspected, serviced, and routine functional tests carried out in accordance with maintenance procedure manuals.4.4 Functional anomalies are identified, isolated and tagged as per the installation and tag out procedure(s).4.5 Motor control system maintenance job cards are filled out in accordance with the workplace procedures. |
| 1. Prepare motor control technical reports and workplace records
 | 5.1 Motor control design, installation procedures, trouble-shooting methods and maintenance data/information are gathered and formulated in the required sequence and format.5.2 Motor control report structure, presentation style and format is determined according to standard operating procedures5.3 Motor control technical report is developed and shared in accordance with standard guidelines and procedures.5.4 Workplace records are maintained in accordance with standard operating procedures5.5 Workplace records, catalogues and other required business documents are created and maintained as per industry-accepted procedures. |

RANGE (Motor Controls Unit)

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| VARIABLE | RANGE |
| 1. Safety may include but are not limited to:
 | * Gloves
* Hard hats
* Protective Footwear
* Eye protection
* Overalls/dust coats
* Ear protection
* Fall arrest/fall protection
* Access to First Aid Training
* Environmental hazards/sensitivity
* Safety lock-out/tag-out procedures
 |
| 1. Tools, drawings, and forms may include but not limited to:
 | * Measurement tools, cutting tools
* Spirit level, multimeters, HV test equipment (CTS, and Meggers), measuring tape (SAE and metric)
* Electrical hand tools (sidecutters, pliers, screwdrivers, wire strippers, exacto knife, crimpers, hacksaw, and other cutting tools)
* Ladders/scaffolding.
* Power tools: drills, Sawzall (reciprocating saw), powder-actuated (Hilti). Bench Vises, pipe vices, drill press, grinders.
* Hoisting equipment.
* Students’ drawings and schematics
* Instructors drawings
* Manufacturer’s drawings
* Lab Equipment drawings
* Record-keeping forms, i.e. Motor Control job rectification cards
* Procedure manuals
* Workplace records, catalogues and other required business documents (i.e. invoices, time & material records, purchase orders and requisitions)
 |
| 1. Equipment – Motor Control Unit may include but not limited to:
 | * Motor Control Centres
* Individual contactors (240V 1 Φ, 415V 3Φ)
* Overload relays
* Disconnecting means
* Φ induction motors (WRM, Synchronous)
* Variable Frequency Drives
* Soft-starts
* 1 Φ motors
* DC Motors
* “Motor/Gensets”
* PLC’s
* Remote monitoring equipment
 |
| 1. Workplace culture expectations and procedures may include but not limited to:
 | * Adherence to workplace policies
* Safety codes
* Anti-Corruption
* Security
* Labour laws
* Attitudes
* Respectful of diversity: gender, religious, and ethnicity
* Respect for, and adherence to, practices of Environmental sustainability
* Punctuality
* Teamwork; ability to work collaboratively with other vocations.
* Integrity
* Work/life balance
* Ability to work independently
* Self-motivation
* Willingness to learn
* Positive demeanor
 |
| 1. Electrical and Electronics Regulations may include but not limited to:
 | * IEEE installation standards
* Permit regulations and processes
* Kenya Engineering Technology Board
* Kenya Electricity Grid code
* National Authority regulatory bodies
* National Construction Authority
 |
| 1. Safe work practices and expectations may include but not limited to:
 | Adherence to:* Local/municipal regulatory bodies
* Hazardous waste disposal regulations
* Stand-alone or industry-specific isolation policy/permits
 |
| 1. Ancillary Structures may include but not limited to:
 | * Industrial settings / electrical vaults
* Manufacturing settings / electrical vaults
* Resource extraction sites
* Marine settings
* Commercial buildings
* Remote locations
* Game parks
* Environmentally-sensitive areas
* Agricultural settings, including livestock
 |

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Safe and proper use of tools and equipment
* Critical thinking
* Analytical skills
* Technical writing skills
* Safely install motor controls
* Safely repair industrial machines and controls
* Accurately conduct performance testing and maintenance on industrial machines and controls
* Safely work on line voltages up to 415 VAC (3Φ)
* Problem-solving

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Electrical symbols and design principles
* National, local, and municipal legislation and regulations
* Workplace policies, procedures, and expectations
* Types of tools, equipment, and PPEs
* Proper design and technical documentation principles
* The operations of electrical motor controls
* Installation, maintenance, repair, replacement of Electrical systems and apparatus
* Troubleshooting electrical systems
* The applications of motors and knowledge of associated motor control
* Awareness of the various settings, (i.e. Industrial, commercial, agricultural.)

EVIDENCE GUIDE – Motor Controls

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:1.1 Wore all required PPE.1.2 Adhered to the safety regulations. 1.3 Adhered to workplace expectations.1.4 Assessed process requirements/application for the installation of the electrical equipment.1.5 Installed electrical equipment, i.e. overloads, overcurrent devices, wiring, and contactors as per manufacturer’s and industry specifications.1.6 Diagnosed and performed industry-accepted actions to properly repair/replace equipment.1.7 Achieved final acceptance, and approval by the customer as per original scope and/or Terms of Reference. 1.8 Repaired the equipment to the required acceptable level of operation.1.9. Replaced parts as per equipment/manufacturers specifications.1.10 Provided maintenance to the required equipment in accordance with best practices.1.11 Produced the required documentation for the proper repair, replacement, installation, and maintenance of electrical equipment. |
| 2. Resource Implications | The following resources must be provided:2.1 Workplace location2.2. PPEs2.3 Access to the required equipment2.4 Tools and equipment2.5 Writing/documentation materials |
| 3. Methods of Assessment | Competency in this unit may be assessed through:ObservationOral presentationFormative mini-projectsSummative projectsWritten technical reports |
| 4. Context of Assessment | Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment.  |
| 5. Guidance information for assessment | Holistic assessment that assess a range of integrated skills and knowledge. |

**MANAGE PROGRAMMABLE LOGIC CONTROLLERS (PLCS) AND SCADA SYSTEMS**

**UNIT CODE:** ENG/OS/IC/CR/02/6/A

**UNIT DESCRIPTION**

This unit articulates the competencies required to become proficient in the safe installation, maintenance and troubleshooting of Programmable Logic Controllers and SCADA systems. It involves the learner to install, troubleshoot, program and test PLC-controlled equipment.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Install PLC & SCADA-associated equipment
 | * 1. PLC and SCADA installation/wiring diagrams are interpreted in accordance with ***IEEE /ISA standards***.
	2. PLC and SCADA installation ***tools, components, equipment, materials and software*** are identified and selected in accordance with installation/***wiring diagrams*** and ***manufacturer specifications/catalogs***
	3. PLC and SCADA systems/modules/equipment are mounted and terminated as per the installation/***wiring diagrams*** and ***manufacturer specifications/catalogs***
	4. SCADA and ***PLC software*** are installed according to ***manufacturer specifications***
	5. PLC and SCADA systems/modules/equipment is energized, and tested in accordance with the design and as per ***manufacturer/industry-accepted specifications.***
	6. PLC and SCADA systems system is energized, and tested in accordance with the ***student’s and/or instructor’s drawings/ design***.
 |
| 1. Configure and Program PLC and SCADA systems
 | * 1. SCADA and PLC configuration ***reference materials, equipment, program and associated software*** are identified and selected according to applications and task plan.
	2. Configuration parameters are identified according ***workplace procedures***
	3. PLC and SCADA language data types and addressing schemes are selected according to ***manufacturer specifications***
	4. I/Os are forced, disabled and bypassed according to ***manufacturer specifications***
	5. PLC /SCADA are configured using ***programming/configuration software***
	6. ***Software and firmware*** are upgraded according to ***manufacturer specifications***
	7. Results are interpreted according to ***workplace procedures***
 |
| 1. Troubleshoot and Repair of PLC/SCADA System
 | * 1. PLC/SCADA diagnostic/troubleshooting tools, ***equipment, software***, are identified and selected in accordance with task requirements and ***manufacturers’ specifications***
	2. PLC/SCADA faulty ***hardware modules*** are identified, replaced/repaired in accordance with ***manufacturers’ specifications/ workplace procedures***
	3. PLC/SCADA ***software*** modules are re-installed/modified according to ***manufacturers’ specifications***
	4. ***Software and firmware*** are upgraded according to ***manufacturers’ specifications***
	5. Functional test(s) are carried out on PLC/SCADA system
	6. PLC/SCADA system ***Job rectification card(s)*** are filled out.
 |
| 1. Maintain and service PLC and SCADA Systems
 | 4.1 PLC/SCADA maintenance ***procedure manuals*** are acquired and, ***maintenance tools/equipment/software*** list prepared and selected in accordance with task requirements.4.2 PLC/SCADA ***hardware/software modules*** inspected, serviced/repaired/re-installed/upgraded and routine functional tests carried out in accordance with ***maintenance procedure manuals***.4.3 SCADA/PLC functional anomalies are identified, isolated and tagged as per the ***installation and tag out procedure(s).***4.4 SCADA/PLC Programs are backed-up according to manufacturers’ ***specifications and workplace procedures*** |
| 1. Prepare SCADA/PLC system

Technical  reports and  work place  records | ***5.1 PLC/SCADA installation procedures, troubleshooting methods and maintenance data/information*** are gathered and formulated in the required sequence and format. 5.2 PLC/SCADA report structure, presentation style and format are determined according to ***standard operating procedures*** and in accordance with industry-accepted specifications. 5.3 PLC/SCADA Technical report(s) are prepared and shared in accordance with ***standard operating procedures.*** ***5.4 Workplace records***, catalogues for PLC/SCADA and other required ***business documents*** in are created and maintained accordance with ***industry-accepted specifications***.  |

**RANGE (PLCs Unit)**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **VARIABLE** | **RANGE** |
| 1. Safety | May include but are not limited to:* Gloves
* Hard hats
* Protective Footwear
* Eye protection
* Overalls/dust coats
* Ear protection
* Fall arrest/fall protection
* Access to First Aid Training
* Environmental hazards/sensitivity
 |
| 2. Tools, drawings, and forms | * Measurement tools, cutting tools
* Spirit level, multimeters, HV test equipment (CTS, and Meggers), measuring tape (SAE and metric)
* Electrical hand tools (side cutters, pliers, screwdrivers, wire strippers, exacto knife, crimpers, hacksaw, and other cutting tools)
* Ladders/scaffolding.
* Power tools: drills, Sawzall (reciprocating saw), powder-actuated (Hilti). Bench Vises, pipe vices, drill press, grinders.
* Hoisting equipment.
* Students’ drawings
* Instructor’s drawings
* Manufacturer’s design drawings, schematics.
* Job rectification cards
* PLC/SCADA installation procedures, troubleshooting methods and maintenance data/information
* Workplace records, catalogues and other required business documents (i.e. invoices, time & material records, purchase orders and requisitions)
 |
| 3. Equipment and associated support – PLC’s | * Stand-alone (shoebox) PLC’s
* Multi-card/racked module PLC’s
* PLC programming software (i.e. Ladder, Functional Block etc.)
* Input-Output termination points (i.e. enclosures)
* Ancillary devices to PLC (i.e. remote programming/laptops and SCADA equipment)
* Individual contactors (240V 1 Φ, 415V 3Φ)
* Overload relays
* Disconnecting means
* 3 Φ induction motors (WRM, Synchronous)
* Variable Frequency Drives
* Soft-starts
* 1 Φ motors
* DC Motors
* “Motor/Gensets”
* Motor Control equipment
* Remote monitoring equipment
 |
| 4. Workplace culture expectations. | Adherence to workplace policies* Safety codes
* Anti-Corruption
* Security
* Labour laws

Attitudes* Respectful of diversity: gender, religious, and ethnicity
* Respect for, and adherence to, practices of Environmental sustainability
* Punctuality
* Teamwork; ability to work collaboratively with other vocations.
* Work/life balance
* Integrity
* Ability to work independently
* Self-motivation
* Willingness to learn
* Positive demeanor
 |
| 5. Regulations to adhere to building codes and standards | Adherence to:* Local/municipal regulatory bodies
* Permit regulations and processes
* Public health and sanitation regulations
* County regulations/bylaws
* National regulatory bodies
* National Construction Authority
* IEEE installation standards
* ISA (Instrument Society of America) standards
* Kenya Electrical Code and Standards
 |
| 1. Safe work practices and expectations
 | Adherence to:* Local/municipal regulatory bodies
* Hazardous waste disposal regulations
* Stand-alone or industry-specific isolation policy/permits
* Lock-out/Tag-out procedures
 |
| 1. Ancillary Structures
 | * Industrial settings / electrical vaults
* Manufacturing settings / electrical vaults
* Resource extraction sites
* Marine settings
* Commercial buildings
* Remote locations
* Game parks
* Environmentally-sensitive areas
* Agricultural settings, including livestock
 |

**REQUIRED SKILLS AND KNOWLEDGE – PLC’s**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Safe and proper use of tools and equipment
* Use critical thinking and analytical skills
* Technical writing skills
* Safely install PLC systems
* Safely repair PLC systems
* Program PLC systems
* Accurately conduct performance testing and maintenance on PLC systems
* Safely work on line voltages up to 415 VAC (3Φ)

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* National, local, and municipal legislation and regulations
* Workplace policies, procedures, and expectations
* Types of tools, equipment, and PPEs
* Proper design and technical documentation principles
* The operations of electrical motor controls
* Installation, maintenance, repair, replacement of PLC systems.
* Installation, maintenance, repair, replacement of Electrical systems and apparatus
* Troubleshooting PLC systems
* Troubleshooting electrical systems
* The applications of motors and knowledge of associated PLC
* The applications of motors and knowledge of associated motor control
* Awareness of the various settings, (i.e. Industrial, commercial, agricultural.)

**EVIDENCE GUIDE – PLC’s**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:* 1. Wore all required PPE.
	2. Adhered to the safety regulations.
	3. Adhered to workplace expectations.
	4. Assessed process requirements/application for the installation of the PLC’s and electrical equipment.
	5. Developed/downloaded and tested his/her PLC program c/w industry accepted documentation standards.
	6. Achieved acceptance of the PLC program: congruent with original process intent.
	7. Installed PLC’s and any related electrical equipment, i.e. overloads, overcurrent devices, wiring, and contactors as per manufacturer’s and industry specifications.
	8. Diagnosed and performed industry-accepted actions to properly repair/replace PLC equipment.
	9. Achieved final acceptance, and approval by the customer as per original scope and/or Terms of Reference.
	10. Repaired the PLC equipment to the required acceptable level of operation.
	11. Replaced PLC parts and components as per manufacturers’ specifications.
	12. Provided maintenance to the required PLC equipment in accordance with best practices.
	13. Produced the required documentation for the proper repair, replacement, installation, and maintenance of PLC’s.
 |
| 2. Resource Implications | The following resources must be provided:2.1 Workplace location2.2. PPEs2.3 Access to the required equipment2.4 Tools and equipment2.5 Writing/documentation materials |
| 3. Methods of Assessment | Competency in this unit may be assessed through: 3.1 Observation 3.2 Oral presentation 3.3 Formative mini-projects 3.4 Summative projects 3.5 Written technical reports |
| 4. Context of Assessment | Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment.  |
| 5. Guidance information for assessment | Holistic assessment that assess a range of integrated skills and knowledge. |

# MANAGE INSTRUMENTATION, PROCESS CONTROL AND P&ID

**UNIT CODE:** ENG/OS/IC/CR/03/6/A

**UNIT DESCRIPTION**

This unit articulates the competencies required to become proficient in the safe installation, maintenance and troubleshooting of instrumentation equipment, sensors, PID in industrial/manufacturing and automated settings. It involves the learner to install, calibrate and test common sensors; i.e. Flow, Pressure, Limit, Proximity, Temperature.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| ELEMENTThese describe the key outcomes which make up workplace function. | PERFORMANCE CRITERIAThese are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Install process control and Instrumentation associated equipment
 | * 1. Piping and Instrumentation Diagrams (P&ID) are interpreted in accordance with ***International Electrotechnical Commission (IEC) standards.***
	2. Materials, components***, tools and equipment*** are identified and selected for installation in accordance ***Piping and Instrumentation Diagrams***
	3. ***Process control and instrumentation equipment*** are mounted as per the ***P&ID.***
	4. Process control and instrumentation system is energized, and tested in accordance with the ***student’s and/or instructor’s design/drawing***.
 |
| 1. Configure and Calibrate Instrumentation sensors and PID controllers
 | * 1. Measurement standards/reference materials and associated equipment for configuration and calibration are identified according the work plan
	2. Calibration platform/condition is set according to the ***manufacture specifications***
	3. ***Calibration methods/ procedures*** for the sensors and PID controllers are determined and executed according to ***manufacture specifications***
	4. Configuration and calibration data are recorded/ developed and documented according to ***workplace procedures.***
 |
| 1. Troubleshoot and Repair of Instrumentation, Process Control and PID Controllers
 | * 1. Instrumentation and ***PID diagnostic/troubleshooting tools*** are selected in accordance with task requirements.
	2. Process control and PID controller faulty components are identified, replaced or repaired in accordance with ***manufacturers’ specifications/catalogue.***
	3. Analog and digital wiring systems are re-terminated in accordance with ***manufacturers’ specifications/catalogue***
	4. ***Instrumentation sensors*** and PID repaired/replaced components are inspected.
	5. ***Instrumentation and process sensors and equipment*** are re-calibrated according to manufacturers’ specifications/catalogs

3.6 Voltage, current, signal and Functional test(s) are carried out on ***Instrumentation sensors and PID controllers***3.7 Instrumentation and ***PID controller Job rectification card(s)*** are filled out. |
| 1. Maintain and service Instrumentation and Process

Control Systems | 1. **Process and Instrumentation system maintenance procedure manuals** are acquired and **materials/tools/equipment** list prepared and selected in accordance with task requirements.
2. Instrumentation system and PID are inspected, serviced, and routine functional tests carried out in accordance with ***maintenance procedure manuals.***
3. Sensor and PID functional anomalies are identified, isolated and tagged as per the installation and ***tag out procedure(s).***
4. Instrumentation system and PID maintenance job cards are filled out in accordance with the ***workplace procedures.***
 |
| 1. Prepare PID control and Instrumentation system

Technical  reports and  work place  records  | * 1. PID controllers and sensors ***installation procedures***, troubleshooting methods and maintenance data/information are gathered and formulated in the required sequence and format.
	2. Process control report structure, presentation style and format are determined according to ***standard operating procedures*** and in accordance with ***industry-accepted specifications***.
	3. Instrumentation system and PID Controller ***Technical report(s)*** are prepared and shared in accordance with ***standard operating procedures.***
	4. Workplace records, ***catalogues*** for PID and ***Instrumentation sensors*** and other required ***business documents*** in are created and maintained accordance with ***industry-accepted specifications***.

  |

**RANGE (Instrumentation and Process Control - Sensors)**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **VARIABLE** | **RANGE** |
| 1. Safety | May include but are not limited to:* Gloves
* Hard hats
* Protective Footwear
* Eye protection
* Overalls/dust coats
* Ear protection
* Fall arrest/fall protection
* Access to First Aid Training
* Environmental hazards/sensitivity
 |
| 2. Tools & Drawings | * Instrument calibration tools.
* 24VDC portable supply.
* Measurement tools, cutting tools
* Spirit level, multimeters, HV test equipment (CTS, and Meggers), measuring tape (SAE and metric)
* Electrical handtools (sidecutters, pliers, screwdrivers, wire strippers, exacto knife, crimpers, hacksaw, and other cutting tools)
* Ladders/scaffolding.
* Power tools: drills, Sawzall (reciprocating saw), powder-actuated (Hilti). Bench Vises, pipe vices, drill press, grinders.
* Hoisting equipment.
* PID drawings
* Loop drawings
* Manufacturer data sheets
* Student drawings
* Instructor drawings
* Job rectification cards
* Manufacturers’ Process and Instrumentation system maintenance procedure manuals
* Instrument Technical reports, Workplace records, catalogues and other required business documents (i.e. invoices, time & material records, purchase orders and requisitions)
 |
| 3. Equipment – Sensors | * Sensors: i.e. tacho-generators, flow, temperature etc.
* Instrumentation Controllers, Transducers, Final Control Elements
* Chart recorders, diagnostic equipment
* PLC’s
* Input-Output termination points (i.e. enclosures)
* Motor control equipment
* 3 Φ induction motors (WRM, Synchronous)
* Variable Frequency Drives
* Soft-starts
* 1 Φ motors
* DC Motors
* “Motor/Gensets”
* Remote monitoring equipment/SCADA systems
 |
| 4. Workplace culture expectations. | Adherence to workplace policies* Safety codes
* Anti-Corruption
* Security
* Labour laws

Attitudes* Respectful of diversity: gender, religious, and ethnicity
* Respect for, and adherence to, practices of Environmental sustainability
* Punctuality
* Teamwork; ability to work collaboratively with other vocations.
* Work/life balance
* Integrity
* Ability to work independently
* Self-motivation
* Willingness to learn
* Positive demeanor
 |
| 5. Regulations to adhere to building codes and standards | Adherence to:* Local/municipal regulatory bodies
* Permit regulations and processes
* Public health and sanitation regulations
* County regulations/bylaws
* National regulatory bodies
* National Construction Authority
* IEEE installation standards
* Kenya Electrical Code and Standards
* Electro technical Commission (IEC) standards.
 |
| 6. Safe work practices and expectations | Adherence to:* Local/municipal regulatory bodies
* Hazardous waste disposal regulations
* Stand-alone or industry-specific isolation policy/permits
 |
| 7. Ancillary Structures | * Industrial settings / electrical vaults
* Manufacturing settings / electrical vaults
* Resource extraction sites
* Marine settings
* Commercial buildings
* Remote locations
* Game parks
* Environmentally-sensitive areas
* Agricultural settings, including livestock
 |

**REQUIRED SKILLS AND KNOWLEDGE – Instrumentation and Process Control - Sensors**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Safe and proper use of tools and equipment
* Use critical thinking and analytical skills
* Technical writing skills
* Safely install/remove Instrumentation and Process Controls systems apparatus
* Safely repair Instrumentation and Process Controls systems apparatus
* Calibrate Instrumentation and Process Controls systems apparatus
* Accurately conduct performance testing and maintenance on Instrumentation and Process Controls systems apparatus
* Safely work on line voltages up to 415 VAC (3Φ)

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* National, local, and municipal legislation and regulations
* Workplace policies, procedures, and expectations
* Types of tools, equipment, and PPEs
* Proper design and technical documentation principles
* The operations of Instrumentation and Process Controls systems apparatus
* Installation, maintenance, repair, replacement of Instrumentation and Process Controls systems apparatus.
* Installation, maintenance, repair, replacement of Instrumentation and Process Controls systems apparatus
* Troubleshooting Instrumentation and Process Controls systems apparatus
* The applications of Instrumentation and Process Controls systems apparatus
* Awareness of the various settings, (i.e. Industrial, commercial, agricultural.)

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:* 1. Wore all required PPE.
	2. Adhered to the safety regulations.
	3. Adhered to workplace expectations.
	4. Assessed process requirements/application for the installation/removal of the Instrumentation and Process Controls systems apparatus.
	5. Achieved acceptance of the *calibrated*Instrumentation and Process Controls systems apparatus: congruent with original process intent.
	6. Diagnosed and performed industry-accepted actions to properly repair/replace Instrumentation and Process Controls systems apparatus.
	7. Achieved final acceptance, and approval by the customer as per original scope and/or Terms of Reference.
	8. Repaired the Instrumentation and Process Controls systems apparatusto the required acceptable level of operation.
	9. Replaced Instrumentation and Process Controls systems apparatusas per manufacturers’ specifications.
	10. Provided maintenance to the required Instrumentation and Process Controls systems apparatusin accordance with best practices.
	11. Produced the required documentation for the proper repair, replacement, installation, and maintenance of Instrumentation and Process Controls systems apparatus.
 |
| 2. Resource Implications | The following resources should be provided:1. Access to relevant workplace where assessment can take place
2. Appropriately simulated environment where assessment can take place
 |
| 3. Methods of Assessment | Competency in this unit may be assessed through:1. Observation
2. Oral presentation
3. Formative mini-projects
4. Summative projects
5. Written technical reports
 |
| 4. Context of Assessment | Competency may be assessed 1. Off the job
2. on the job
3. During industrial attachment
 |
| 5. Guidance information for assessment | Holistic assessment that assess a range of integrated skills and knowledge. |

#

# MANAGE HIGH VOLTAGE SYSTEMS

**UNIT CODE:** ENG/OS/IC/CR/04/6/A

**UNIT DESCRIPTION**

This unit articulates the competencies required to become proficient in the safe installation, maintenance and troubleshooting of equipment associated with Voltages in excess of 660 VAC 3 Φ.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| ELEMENTThese describe the key outcomes which make up workplace function. | PERFORMANCE CRITERIAThese are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Determine high voltage systems location | * 1. High Voltage systems locations are selected in accordance with accepted ***IEEE standards.***
	2. High voltage locations’ earth is measured for resistivity and conductance.
	3. High voltage locations are selected based on exposure to weather and climatic conditions.
 |
| 2. Order high voltage system components and Prepare High Voltage System Work plan | 1. ***High voltage components*** are selected based on electrical capacity, i.e. ampacity, insulation and environmental conditions.
2. ***High voltage Work plans*** are developed congruent with the intended systems needs
3. ***High voltage components*** are selected based on needs with consideration to cost, longevity, quality and availability.
 |
| 3. Install High Voltage-associated equipment, using bestpractices | 3.1 ***High voltage drawings*** are interpreted in accordance with ***electrical and electronics regulation.*** 3.2 ***High voltage tools*** are selected for installation as per the circuit components and parts.3.3 ***High Voltage systems*** are installed adhering to best safety practices.3.4 ***High voltage*** ***connections*** (i.e. splices, terminations) are installed correctly in accordance with ***IEEE standards and work place regulations.***3.5 ***High voltage Switch gear*** is installed correctly in accordance with ***IEEE standards and work place regulations.***3.6 Adherence to safety for the various voltages associated with HV systems: 125VDC, 240 VAC 1 Φ, 415 3 Φ AC, 660 3 Φ AC and above is demonstrated in accordance with ***IEEE regulations.***3.7 High voltage circuit is energized and tested in accordance with the design.3.8 High voltage ***lock-out/Tag-out procedures*** properly demonstrated in accordance with ***accepted safety regulations***3.9 ***High voltage measuring devices*** for the presence of energy sources, i.e. electrical, pneumatic, springs, hydraulics, and heat and stored energy (capacitors & batteries) are properly used. |
| 4. Troubleshoot and Repair High Voltage Systems  | 4.1 Faults in High Voltage systems are accurately identified and located in accordance with task requirements.4.2 High Voltage systems’ circuit faults are analyzed.4.3 Repair strategies and solutions are identified.4.4 Faults in HV systems are predicted and located.4.5 Faulty HV equipment is located, replaced and/or repaired using ***manufacturers’ specifications/catalogs and manuals.***4.6 ***Parts and equipment*** due to faults in HV systems are replaced as per manufacture specifications.4.7 Basic repairs on HV systems are conducted applying knowledge of proper design principles to read and interpret ***relevant technical documents.*** 4.8 HV systems ***Job rectification card(s)*** are filled out. |
| 5. Maintain High Voltage Systems | 5.1 ***High voltage equipment*** is maintained in good working order using ***manufacturers’ specifications/catalogs and manuals.***5.2 Maintenance on HV equipment is conducted applying knowledge of proper design principles to read and interpret relevant ***technical documents.***5.3 Performance tests on HV systems are carried out as per ***industry-accepted practices.*** |
| 6. Maintain and Prepare High Voltage Systems workplace records and Technical Reports | 6.1 ***Protective relay data sheet*** are correctly filled out.6.2 ***Proper design principles*** to identify symbols, characters etc. in schematics, One-Line drawings, ***and technical documentation*** are applied.6.3 ***Power Distribution and One-line diagrams*** are produced.6.4 High Voltage installation, repair, and maintenance records for systems are documented according to workplace procedure and ***manufacturer specifications.***6.5 Industry standard formatting, terminology, and symbols are used to produce One-line drawings.6.6 Workplace records, catalogues and other required ***business documents*** are created and maintained. |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **VARIABLE** |  **RANGE** |
| 1. Safety may include but are not limited to: |  * Gloves: regular and High Voltage
* ‘Hot-stick’
* Arc Flash equipment
* Hard hats
* Protective Footwear
* Eye protection
* Overalls/dust coats
* Ear protection
* Fall arrest/fall protection
* Access to First Aid Training
* Environmental hazards/sensitivity
* Breaker grounding straps
 |
| 2. Tools, drawings and documentation may include but are not limited to: | * Measurement tools, cutting tools
* Spirit level, mustimeters (AVO), HV test equipment (CTS, and Meggers), measuring tape (SAE and metric)
* Electrical hand tools (side cutters, pliers, screwdrivers, wire strippers, exact knife, crimpers, hacksaw, and other cutting tools)
* Ladders/scaffolding.
* Power tools: drills, Sawzall (reciprocating saw), powder-actuated (Hilti). Bench Vises, pipe vices, drill press, grinders.
* Hoisting equipment.
* HV Doble test equipment
* Ropes
* Chain blocks, ‘come-alongs’
* Lift Truck/Bucket truck
* Pole climbing harness equipment
* Manufacturers’ catalogs
* Manufacturers’ procedural documentation
* Job record repair/rectification cards
* Workplace records, catalogues and other required business documents (i.e. invoices, time & material records, purchase orders and requisitions)
* Power Distribution and One-line diagrams
 |
| 3. Equipment – HVmay include but are not limited to: | * Protective HV relays, i.e. 50/51 Overcurrent/overload.
* Protective HV relay data sheets
* SCADA Systems
* High voltage termination kits
* High voltage splice kits
* Power Measurement recorders
* PT’s, CT’s
* HV Breakers: SF6, ‘Air-break’
* Disconnects (motorized etc.)
* Chart recorders, diagnostic equipment
* Input-Output termination points (i.e. enclosures)
* Motor control equipment
 |
| 4. Workplace culture expectations may include but are not limited to: | Adherence to workplace policies* Safety codes
* Anti-Corruption
* Security
* Labour laws

Attitudes* Respectful of diversity: gender, religious, and ethnicity
* Respect for, and adherence to, practices of Environmental sustainability
* Punctuality
* Teamwork; ability to work collaboratively with other vocations.
* Work/life balance
* Integrity
* Ability to work independently
* Self-motivation
* Willingness to learn
* Positive demeanor
 |
| 1. Regulations to adhere to building codes and standards may include but are not limited to:
 | Adherence to:* Local/municipal regulatory bodies
* Permit regulations and processes
* Public health and sanitation regulations
* County regulations/bylaws
* National regulatory bodies
* National Construction Authority
* IEEE installation standards
* Kenya Electrical Code and Standards
 |
| 1. Safe work practices and expectations may include but are not limited to:
 | Adherence to:* Local/municipal regulatory bodies
* Hazardous waste disposal regulations
* Stand-alone or industry-specific isolation policy/permits
 |
| 1. Ancillary Structures may include but are not limited to:
 | * Substations
* High Voltage switching yards
* Residential/Commercial electrical distribution locations
* Industrial settings / electrical vaults
* Remote Transmission line locations
* Hydro-electric, Geothermal generation plants, etc.
* Manufacturing settings / electrical vaults
* Resource extraction sites
* Marine settings
* Commercial buildings
* Game parks and forested settings
* Environmentally-sensitive areas
* Agricultural settings, including livestock
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Safe and proper use of tools and equipment
* Use critical thinking and analytical skills
* Technical writing skills
* HV cable splicing
* HV cable terminations
* Testing HV cables for dielectric/insulation integrity
* Safely install/remove High Voltage equipment
* Safely repair High Voltage equipment
* Calibrate High Voltage protective relays
* Accurately conduct performance testing and maintenance on High Voltage equipment
* Safely work on line voltages up to ***and in excess*** of 415 VAC (3Φ)

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* National, local, and municipal legislation and regulations
* Workplace policies, procedures, and expectations
* Types of tools, equipment, and PPEs
* Proper design and technical documentation principles
* The operations of High Voltage equipment
	+ Distribution Systems
	+ Cables and Terminations
	+ AC Switchgear and Fuses
	+ Protective Relaying
	+ High Voltage Test Equipment
* Installation, maintenance, repair, replacement of High Voltage equipment
* Troubleshooting High Voltage equipment
* The applications of High Voltage equipment
* Awareness of the various settings, (i.e. Industrial, commercial, agricultural.)

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:* 1. Wore all required PPE.
	2. Adhered to the safety regulations.
	3. Adhered to workplace expectations.
	4. Assessed requirements/application for the installation/removal of the High Voltage equipment.
	5. Diagnosed and performed industry-accepted actions to properly repair/replace High Voltage equipment
	6. Achieved final acceptance, and approval by the customer as per original scope and/or Terms of Reference.
	7. Repaired the High Voltage equipmentto the required acceptable level of operation.
	8. Replaced High Voltage equipment as per manufacturers’ specifications.
	9. Provided maintenance to the required High Voltage equipmentin accordance with best practices.
	10. Produced the required documentation for the proper repair, replacement, installation, and maintenance of High Voltage equipment.
 |
| 2. Resource Implications | The following resources must be provided:2.1 Workplace location2.2. PPEs2.3 Access to the required equipment2.4 Tools and equipment2.5 Writing/documentation materials |
| 3. Methods of Assessment | Competency in this unit may be assessed through:1. Observation
2. Oral presentation
3. Formative mini-projects
4. Summative projects
5. Written technical reports
 |
| 4. Context of Assessment | Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment.  |
| 5. Guidance information for assessment | Holistic assessment that assess a range of integrated skills and knowledge. |

# ANALYZE ALTERNATIVE ENERGY/SOLAR PV

**UNIT CODE:** ENG/OS/IC/CR/05/6/A

**UNIT DESCRIPTION**

This unit articulates the competencies required to become proficient in the safe installation, maintenance and troubleshooting of solar electric associated equipment for off grid applications excluding AC (Alternating Current) production settings. It involves the learner to design, install and test common solar electric components. (i.e. Site Assessment Equipment, Photovoltaic (PV) Panels, Charge Controllers and Batteries)

**ELEMENTS AND PERFORMANCE CRITERIA**

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| --- | --- |
| **ELEMENT**These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Identify and compare alternative energy systems
 | 1.1 ***Alternative energy systems*** are analyzed with respect to parameters such as: ampacity, voltage, location, kwh capacity, ROI (return on investment) and sustainability.1.2 ***Alternative energy systems***, such as Wind, Geothermal, Solar PV, wave and tidal, and Biogas are compared in terms of viability (revenue stream). |
| 1. Determine alternative energy systems locations
 | 2.1 A/E locations are assessed for A/E system viability.2.2 Climatic conditions, i.e. wind patterns, solar irradiance, geothermal activity, etc. are analyzed with respect to location suitability. |
| 1. Determine Alternative energy equipment
 | 3.1 ***A/E Equipment*** is selected based on application and within the ***regulations*** and ***associated standards***.3.2. Electrical equipment for A/E systems is sized in accordance with ampacity, insulation, and environmental requirements as set by applicable ***electrical standards***. |
| 1. Install alternative energy electrical systems safely
 | * 1. ***Alternative Energy*** ***systems*** are installed safely.
	2. Electrical connections for A/E systems are safely terminated in accordance with applicable ***electrical regulations and standards***.
	3. Safety for the various voltages associated with ***Alternative Energy systems***: i.e., 125VDC, 240 VAC 1 Φ, 415 3 Φ AC, 660 3 Φ AC and above is adhered to.
	4. ***PPE*** is properly used in accordance with jurisdictional requirements.
	5. ***Lock-out/Tag-out procedures*** are performed.
	6. ***Measuring devices*** are used to detect the presence of energy sources, i.e. electrical, pneumatic, springs, hydraulics, and heat and stored energy (capacitors & batteries) as per industry-accepted practices.
 |
| 1. Troubleshoot and Repair A/E electrical systems
 | * 1. Faults in ***A/E electrical systems*** are identified and located as per established ***troubleshooting procedures***.
	2. Repair strategies and solutions to solve the problem are identified and applied according to ***work-standard procedures.***
	3. Recommendations to mitigate further faults are applied as per established and ***industry-accepted procedures***.
	4. Proper design principles, based on ***industry-accepted*** nomenclature to identify symbols, characters etc. in schematics, and technical documentation are applied.
	5. Performance test(s) on repaired and/or replaced equipment in A/E systems in accordance with ***manufacturers’ and*** ***industry-accepted standards and procedures.***
 |
| 1. Maintain A/E electrical systems
 | 6.1 ***Standard procedures*** to maintain A/E electrical equipment towards good working order is performed as per ***manufacturers’ specifications/catalogs, and manuals.***6.2 Proper design principles to read and interpret relevant technical documents to conduct maintenance on HV equipment is applied.6.3 Periodic test(s) on maintained A/E systems in accordance with ***manufacturers’ and industry-accepted standards and procedures*** are performed. |
| 1. Prepare and Maintain Alternative Energy Electrical systems workplace records and technical reports
 | * 1. A/E electrical ***systems parts and components’ data sheets*** are prepared and archived as per ***industry-accepted record-keeping practices***.
	2. , ***A/E drawings, technical reports, schematics, ‘log book’ entries/records*** repair and maintenance records are created, distributed, organized and archived as per ***industry standards***.
	3. All A/E associated drawings are developed in accordance with ***industry standard*** formatting, terminology, and symbols.
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **VARIABLE** | **RANGE** |
| 1. Safety may include but not limited to: | * Gloves
* Hard hats
* Protective Footwear
* Eye protection
* Ear protection
* Fall arrest/fall protection
* Access to First Aid Training
* Environmental hazards/sensitivity
 |
| 2. Tools, drawings and documentation may include but not limited to: | * Measurement tape SAE and metric.
* Ladder.
* Fall arrest and harness
* Multimeter with DC amperage reading
* Screwdrivers
* Allen/hex keys
* Torque wrench
* Wire stripping tool
* Crimping tools for various electrical connectors
* MC4 connector tool
* Manufacturers’ equipment maintenance and installation procedures and instructions manuals.
* A/E drawings, technical reports, schematics, ‘log book’ entries/records.
 |
| 3. Equipment – Alt energy may include but not limited to: | * Renewable Energy Systems trainer (Student workstation)
* Solar Pathfinder
* Solmetric Sun Eye shade tool (or equivalent)
* Hand-held pyranometer
* TES Solar Power Meter
* Apogee Solar Power meter (or equivalent)
* MC4 connectors (male and female)
* Sun-blocking covers
* Digital camera
 |
| 4. Workplace culture expectations may include but not limited to: | Adherence to workplace policies* Safety codes
* Anti-Corruption
* Security
* Labour laws

Attitudes* Respectful of diversity: gender, religious, and ethnicity
* Respect for, and adherence to, practices of Environmental sustainability
* Punctuality
* Teamwork; ability to work collaboratively with other vocations.
* Integrity
* Work/life balance
* Ability to work independently
* Self-motivation
* Willingness to learn
* Positive demeanor
 |
| Regulations to adhere to building codes and standards may include but not limited to: | Adherence to:* ERC: Energy Regulatory Commission
* Local/municipal regulatory bodies
* Permit regulations and processes
* Public health and sanitation regulations
* County regulations/bylaws
* National regulatory bodies
* National Construction Authority
* IEEE installation standards
* Kenya Electrical Code and Standards
 |
| Safe work practices and expectations may include but not limited to: | Adherence to:* Local/municipal regulatory bodies
* Hazardous waste disposal regulations
* Stand-alone or industry-specific isolation policy/permits
* Lock-out/tag-out procedures
* Trouble-shooting procedures
 |
| Ancillary Structures may include but not limited to: | * Battery room(s)
 |

 **REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

The safe installation, maintenance and troubleshooting of solar electric associated equipment for off grid applications excluding AC (Alternating Current) production settings. It involves the learner to design, install and test common solar electric components. (i.e. Site Assessment Equipment, Photovoltaic (PV) Panels, Charge Controllers and Batteries)

**Required Skills**

The individual needs to demonstrate the following skills:

* Safe and proper use of tools and equipment
* Use critical thinking and analytical skills
* Safely install electrical/electronic equipment, using best practices for solar equipment
* Safely work on voltages up to 415 VAC / DC
* Technical writing skills

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* National / local and municipal legislations and regulations
* Workplace policies, procedures, and expectations
* Types of tools, equipment and PPEs
* Proper design and technical documentation principles.
* The utilization of solar energy for a given application.
* Operation and installation of basic solar equipment.

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Wore all required PPE.
	2. Adhered to the safety guidelines.
	3. Adhere to workplace expectations.
	4. Identified the solar resource at a location.
	5. Designed required electrical load required as per specifications proposed by the client.
	6. Identified the solar equipment in accordance with the site assessment.
	7. Managed / made recommendations for site-specific conditions according to the site assessment for the capture of the solar energy.
	8. Produced a complete site assessment c/w list of components for the client.
	9. Advised on the location of the PV panels to be placed on site.
	10. Advised on the limitations of balance of system equipment in the mounting of PV panels and associated equipment.
	11. Identified the battery containment size and location.
	12. Designed the wire sizing and over current protection for the interconnection of the overall system
	13. Tested the output of the PV system collectively for functionality
 |
| 1. Resource Implications
 | The following resources must be provided:1. Access to relevant workplace where assessment can take place
2. Appropriately simulated environment where assessment can take place
 |
| 1. Methods of Assessment
 | Competency may be assessed through:* 1. Observation
	2. Oral presentation
	3. Formative mini-projects / labs
	4. Written technical reports
 |
| 1. Context of Assessment
 | Competency may be assessed 1. Off the job
2. on the job
3. During industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment that assess a range of integrated skills and knowledge. |