

**REPUBLIC OF KENYA**

**NATIONAL OCCUPATIONAL STANDARDS**

**FOR**

**INSTRUMENTATION AND CONTROL TECHNICIAN**

**LEVEL 5**



 TVET CDACC

P.O BOX 15745-00100

NAIROBI

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**Council Secretary/CEO**

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**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 of Kenya’s development blueprint 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. A key feature of this policy is the radical change in the design and delivery of the TVET training. This policy document requires that training in TVET be competency based, curriculum development be industry led, certification be based on demonstration of competence and mode of delivery allows 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 was developed for the purpose of developing a competency-based curriculum for instrumentation control technician level 5. 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 Sessional Paper No. 14 of 2012 on Reforming Education and Training in Kenya, emphasized the need to reform curriculum development, assessment, and certification. This called for a shift to CBET in order 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 Instrumentation and Control Sector Skills Advisory Committee (SSAC) have developed these Occupational Standards for Instrumentation and Control technician Level 5. These standards will be the basis for development of competency-based curriculum for Instrumentation and Control Level 5.

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 the Council Members, Council Secretariat, Instrumentation and Control SSAC, expert workers 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 Instrumentation and Control 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 other institutions which in one way or another contributed to the development of these Standards.

**CHAIRPERSON INSTRUMENTATION AND CONTROL SECTOR SKILLS ADVISORY COMMITTEE**

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# ABBREVIATIONS AND ACRONYMS

A Control Version

AC Alternate Current

AIDS Acquired Immunodeficiency Syndrome

BC Basic Competencies

BJT Bipolar Junction Transistor

CAD Computer Aided Design

CBET Competency Based Education and Training

CC Common Competencies

CR Core Competencies

CDACC Curriculum Development, Assessment and Certification Council

CEO Council Secretary

CPU Central Processing Unit

DC Direct Current

DCS Distributed Control System

ENG Engineering

EHS Environment, Health and Safety

EPRA Energy and Petroleum Regulatory Authority

ET Electronics Technician

FETs Field Effect Transistor

HIV Human Immunodeficiency Virus

ICT Information Communication Technology

IP Ingress Protection

HMI Human-Machine Interface

IEE Institute of Electrical Engineers

LED Light Emitting Diode

NPN Negative Positive Negative

OS Occupational Standards

OSHA Occupational Safety and Health Act

 PESTEL Political Environmental Social Technological Economic Legal

 PLC Programmable Logic Controller

 PNP Positive Negative Positive

 PPE Personal Protective Equipment

 PPMC Permanent Magnet Moving Coil

 SCADA Supervisory Control and Data Acquisition

 SOP Standard Operating Procedures

 SSAC Sector Skill Advisory Committee

 SWOT Strength Weakness Opportunity Threat

 TVET Technical and Vocational Education and Training

# KEY TO UNIT CODE

ENG/OS/IC/BC/01/5/A

Industry or sector

Occupational Standards

Occupational area

Type of competency

Competency number

Competency level

 Control Version

**OVERVIEW**

Instrumentation and Control technician Level 5 qualification consists of competencies that a person must achieve to enable him/her perform electrical installation,install power supply systems, install electrical machine control systems, apply electrical instrumentation and maintain radio frequency systems.

**Units of Competency**

This course consists of basic, common and core units of competency as indicated below:

**BASIC COMPETENCIES**

|  |  |
| --- | --- |
| **Unit Code** | **Unit Title** |
| ENG/OS/IC/BC/01/5/A | Demonstrate Communication Skills |
| ENG/OS/IC/BC/02/5/A | Demonstrate Digital Literacy |
| ENG/OS/IC/BC/03/5/A | Demonstrate Entrepreneurial Skills |
| ENG/OS/IC/BC/04/5/A | Demonstrate Employability Skills |
| ENG/OS/IC/BC/05/5/A | Demonstrate Environmental Literacy |
| ENG/OS/IC/BC/06/5/A | Demonstrate Occupational Safety and Health Practices |

**COMMON COMPETENCIES**

|  |  |
| --- | --- |
| **Unit Code** | **Unit Title** |
| ENG/OS/IC/CC/01/5/A | Apply Engineering Mathematics |
| ENG/OS/IC/CC/02/5/A | Demonstrate Understanding of Electronics |
| ENG/OS/IC/CC/03/5/A | Perform Workshop Processes |
| ENG/OS/IC/CC/04/5/A | Apply Electrical Principles |
| ENG/OS/IC/CC/05/5/A | Prepare and Interpret Technical Drawing |

**CORE COMPETENCIES**

|  |  |
| --- | --- |
| **Unit Code** | **Unit Title** |
| ENG/OS/IC/CR/01/5/A | Perform Electrical Installation |
| ENG/OS/IC/CR/02/5/A | Install Power Supply Systems |
| ENG/OS/IC/CR/03/5/A | Install Electrical Machine Control Systems |
| ENG/OS/IC/CR/04/5/A | Apply Electrical Instrumentation |
| ENG/OS/IC/CR/05/5/A | Maintain Radio Frequency Systems |

**BASIC UNITS OF COMPETENCY**

#  DEMONSTRATE COMMUNICATION SKILLS

**UNIT CODE: ENG/OS/IC/BC/01/5/A**

**UNIT DESCRIPTION**

This unit covers the competencies required to demonstrate communication skills. It involves meeting communication needs of clients and colleagues, contributing to the development of communication strategies, conducting workplace interviews, facilitating group discussions 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. Contribute to the development of communication strategies
 | 1. Strategies for internal and external dissemination of information are developed, promoted, implemented and reviewed as per organizations’ strategic plan
2. Channels of communication are established and reviewed based on the workplace needs
3. Communication training needs are identified and provided according to SOPs
4. Work related network and relationship are maintained based on workplace requirements
5. Negotiation and conflict resolution strategies are maintained as per the workplace procedures
 |
| 1. Conduct workplace interviews
 | 1. ***Communication strategies*** are identified and employed in ***interview situations*** based on 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 based on needs
 |
| 1. Facilitate group discussions
 | 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. Relevant presentation is researched and presented based on internal or external communication forums requirements Presentation is delivered in a clear and sequential manner as per the predetermined time
2. Presentation is made as per appropriate media
3. Difference views are respected based on workplace procedures
4. Written communication is done as per organizational standards
5. 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 non-judgmental 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
* Openness and flexibility in communication
 |
| 1. Interview 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:

* Active listening
* Giving/receiving feedback
* Interpretation of information
* Role boundaries setting
* Negotiation
* Communication

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Communication process
* Dynamics of groups and different styles of group leadership
* Communication skills relevant to client groups
* Flexibility in communication

**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. Met communication needs of clients and colleagues
2. Contributed to the development of communication strategies
3. Conducted interviews
4. Facilitated group discussions
5. Represented the organization
 |
| 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/02/5/A

**UNIT DESCRIPTION**

This unit covers the competencies required to demonstrate digital literacy. It involves identifying appropriate computer software and hardware, applying security measures to data, hardware, software in automated environment, applying computer software in solving tasks, applying internet and email in communication at workplace, applying desktop publishing in official assignment 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 ofoperating system are determined in accordance withmanufacturer’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*** areidentified, **and *control measures*** are applied in accordance with laws governing protection of ICT
3. Computer threats and crimes are detected in accordance with Information security management 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 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:
 | * Computer case
* Monitor
* keyboard
* mouse
 |
| 1. Data security and privacy may include but not limited to:
 | * Confidentiality of data
* Cloud computing
* Integrity -but-curious data surfing
 |
| 1. Security and control measures may include but not limited to:
 | * Counter measures against cyber terrorism
* Risk reduction
* Cyber threat issues
* Risk management
* Pass wording
 |
| 1. Security threats may include but not limited to:
 | * Cyber terrorism
* 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:

* Analytical skills
* Interpretation
* Typing
* Communication
* Basic ICT skills

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Software concept
* Functions of computer software and hardware
* Data security and privacy
* Computer security threats and control measures
* Technology underlying cyber-attacks and networks
* Cyber terrorism
* Computer crimes
* Detection and protection of computer crimes
* Laws governing protection of ICT
* Microsoft suite

**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
 | 1. Tablets
2. Laptops
3. Desktop computers
4. Calculators
5. Internet
6. Smart phones
7. Operation Manuals
 |
| 1. Methods of Assessment
 | Competency may be assessed through:1. Written Test
2. Observation
3. Practical assignment
4. Interview/Oral Questioning
 |
| 1. Context of Assessment
 | Competency may be assessed in:1. Off the job
2. On the job setting
3. Industrial attachment
 |
| 5. 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/03/5/A

**UNIT DESCRIPTION**

This unit covers the competencies required to demonstrate entrepreneurial skills. 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 Businesspersons 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.

|  |  |
| --- | --- |
| 1. **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
 | Assessment requires evidence that the candidate:1. Distinguished entrepreneurs and business persons correctly
2. Identified ways of becoming an entrepreneur appropriately
3. Explored factors affecting entrepreneurship development appropriately
4. Analysed importance of self-employment accurately
5. Identified requirements for entry into self-employment correctly
6. Identified sources of business ideas correctly
7. GeneratedBusiness ideas and opportunities correctly
8. Analysed business life cycle accurately
9. Identified legal aspects of business correctly
10. Assessed product demand accurately
11. Determined Internal and external motivation factors appropriately
12. Carried out communications effectively
13. Identified sources of business finance correctly
14. Determined Governing policy on small scale enterprise appropriately
15. Explored problems of starting and operating SSEs effectively
16. Developed Marketing, Organizational/Management, Production/Operation and Financial plans correctly
17. Prepared executive summary correctly
18. Determined business innovative strategies appropriately
19. Presented business plan effectively
 |
| 1. Resource Implications
 | 1. The following resources should be provided:
2. Access to relevant workplace where assessment can take place
3. 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
 |
| 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/04/5/A

**Unit Description**

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

**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 small teams
 | 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. Task requirements are identified as per the workplace objectives
2. Task is interpreted in accordance with safety (OHS ), environmental requirements and quality requirements
3. Work activity is organized with other involved personnel as per the SOPs
4. Resources are mobilized, allocated and utilized to meet project goals and deliverables.
5. Work activities are monitored and evaluated in line with organization procedures.
6. Job planning is documented in accordance with workplace requirements.
7. Time is managed achieve workplace set goals and objectives.
 |
| 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. Demonstrate workplace ethics
 | 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.

|  |  |
| --- | --- |
| **Range** | **Variable** |
| 1. Drug and substance abuse may include but not limited to:
 | * Commonly abused
* Alcohol
* Tobacco
* Miraa
* Over-the-counter drugs
* Cocaine
* Bhang
* Glue
 |
| 1. Feedback may include but not limited to:
 | * Verbal
* Written
* Informal
* Formal
 |
| 1. Relationships may include but not limited to:
 | * Man/Woman
* Trainer/trainee
* Employee/employer
* Client/service provider
* Husband/wife
* Boy/girl
* Parent/child
* Sibling relationships
 |
| 1. Forms of communication may include but not limited to:
 | * Written
* Visual
* Verbal
* Non verbal
* Formal and informal
 |
| 1. Team may include but not limited to:
 | * Small work group
* Staff in a section/department
* Inter-agency group
 |
| 1. Personal growth may include but not limited to:
 |

|  |
| --- |
| * Growth in the job
* Career mobility
* Gains and exposure the job gives
* Net workings
* Benefits that accrue to the individual as a result of noteworthy performance
 |

 |
| 1. Personal objectives may include but not limited to:
 | * Long term
* Short term
* Broad
* Specific
 |
| 1. Trainings and career opportunities may include but not limited to
 | * Participation in training programs
* Technical
* Supervisory
* Managerial
* Continuing Education
* Serving as Resource Persons in conferences and workshops
 |
| 1. Resource may include but not limited to:
 | * Human
* Financial
* Hardware
* Software
 |
| 1. Innovation may include but not limited to:
 | * New ideas
* Original ideas
* Different ideas
* Methods/procedures
* Processes
* New tools
 |
| 1. Emerging issues may include but not limited to:
 | * Terrorism
* Social media
* National cohesion
* Open offices
 |
| 1. Range of media for learning may include but not limited to:
 | * Mentoring
* peer support and networking
* 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:

* Communication
* Critical thinking
* Observation
* Organizing
* Negotiation
* Monitoring
* Evaluation
* Record keeping
* Problem solving
* Decision Making
* Resource utilization
* Resource mobilization

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Work values and ethics
* Company policies
* Company operations, procedures and standards
* Occupational Health and safety procedures
* Fundamental rights at work
* Personal hygiene practices
* Workplace communication
* Concept of time
* Time management
* Decision making
* Types of resources
* Work planning
* Resources and allocating resources
* Organizing work
* Monitoring and evaluation
* Record keeping
* Workplace problems and how to deal with them
* Gender mainstreaming
* HIV and AIDS
* Drug and substance abuse
* Leadership
* Safe work habits
* Professional growth and development
* Technology in the workplace
* Emerging issues
* Social media
* Terrorism
* National cohesion

###### **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. Led small teams
5. Planned and organized work
6. Maintained professional growth and development
7. Demonstrated workplace learning
8. Demonstrated problem solving skills
9. Demonstrated workplace ethics
 |
| 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. Oral questioning
2. Portfolio of evidence
3. Third Party Reports
4. Written tests
 |
| 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/05/5/A

**UNIT DESCRIPTION**

This unit describes the competencies required to demonstrate understanding of environmental literacy. It involves controlling environmental hazard, controlling control environmental pollution, complying with workplace sustainable resource use, evaluating current practices in relation to resource usage, identifying environmental legislations/conventions for environmental concerns, implementing specific environmental programs and monitoring activities on environmental protection/programs.

**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 always according to environmental regulations and OSHS.
3. ***PPE*** is used according to OSHS.
 |
| 1. Control environmental Pollution control
 | 1. Environmental pollution ***control measures*** are compiled following standard protocol.
2. Procedures for solid waste management are observed according to 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.
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 Environmental Management and Coordination Act 1999
 |
| 1. Evaluate current practices in relation to resource usage
 | 1. Information on resource efficiency **systems and procedures** are collected and provided to the work group where appropriate.
2. Current resource usage is measured and recorded by members of the 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 concerned/proper authorities
 |

**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
* Safety boots
 |
| 1. Environmental pollution 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
 |
| 1. Waste management procedures may include but not limited to:
 | * Sorting
* Storing of items
* Recycling of items
* Disposal of items
 |
| 1. Resources may include but not limited to:
 | * Electric
* Water
* Fuel
* Telecommunications
* Supplies
* Materials
 |
| 1. Workplace environmental hazards may include but not limited to:
 | * Biological hazards
* Chemical and dust hazards
* Physical hazards
 |
| 1. Organizational systems and procedures may include but not limited to:
 | * Supply chain, procurement and purchasing
* Quality assurance
* Making recommendations and seeking approvals
 |

**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:

* Observation
* Measuring
* Writing
* Communication
* Analytical
* Monitoring
* Evaluation

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Storage methods of environmentally hazardous materials
* Disposal methods of hazardous wastes
* Usage of PPE Environmental regulations
* OSHS
* Types of pollution
* Environmental pollution control measures
* Different solid wastes
* Solid waste management
* Different noise pollution
* Methods of minimizing noise pollution
* Solid Waste Act
* Methods of minimizing wastage
* Waste management procedures
* Economizing of resource consumption
* 3Rs principle
* Types of resources
* Techniques in measuring current usage of resources
* Calculating current usage of resources
* Types of workplace environmental hazards
* Environmental regulations
* Environmental regulations applying to the enterprise.
* Measurement and recording of current resource usage
* Analysis current work processes to access information and data Analysis of data and information
* Identification of areas for improvement
* Resource consuming processes
* Determination of quantity and nature of resource consumed
* Analysis of resource flow of different parts of the resource flow process
* Use/conversion of resources
* Causes of low efficiency of use
* Increasing the efficiency of resource use
* Inspection of resource use plans
* Regulations/licensing requirements
* Determine benefit/cost for alternative resource sources
* Benefit/costs for different alternatives
* Components of proposals
* Criteria on ranking proposals
* Regulatory requirements
* Proposals for improving resource efficiency
* Implementation of resource efficiency plans
* Procedures in monitor implementation
* Adjustments of implementation plan
* Inspection of new resource usage

**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 (ex. Cleaning tools, cleaning materials, trash bags, etc.)
3. PPE
4. Manuals and references
5. Legislation, policies, procedures, protocols and local ordinances relating to environmental protection
6. 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. Interview/Third Party Reports
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 OCCUPATIONAL SAFETY AND HEALTH PRACTICES

**UNIT CODE:** ENG/OS/IC/BC/06/5/A

**UNIT DESCRIPTION**

This unit specifies the competencies required to identify workplace hazards and risk, identify and implement appropriate control measures and implement 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 are not limited to:
 | * Physical hazards
* Biological hazards
* Chemical hazards
* Ergonomics
* Psychological factors
* Physiological factors
* Safety hazards
* Unsafe workers’ act
 |
| 1. Indicators may include but are 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. Evaluation and/or work environment measurements may include but are not limited to:
 | * Health Audit
* Safety Audit
* Work Safety and Health Evaluation
* Work Environment Measurements of Physical and Chemical Hazards
 |
| 1. OSH issues and/or concerns may include but are 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. Prevention and control measures may include but are not limited to:
 | * Eliminate the hazard
* Isolate the hazard
* Substitute the hazard with a safer alternative
* Use administrative controls to reduce the risk
* Use engineering controls to reduce the risk
* Use personal protective equipment
* Safety, Health and Work Environment Evaluation
* Periodic and/or special medical examinations of workers
 |
| 1. Safety gears /PPE (Personal Protective Equipment’s) may include but are 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
 | * Eliminate the hazard altogether
* Isolate the hazard from anyone who could be harmed
* Substitute the hazard with a safer alternative
* Use administrative controls to reduce the risk
* Use engineering controls to reduce the risk
* Use personal protective equipment
 |
| 1. Contingency measures may include but are not limited to:
 | * Evacuation
* Isolation
* Decontamination
* Emergency personnel
 |
| 1. Emergency procedures may include but are not limited to:
 | * Fire drill
* Earthquake drill
* Basic life support/CPR
* First aid
* Spillage control
* Decontamination of chemical and toxic
* Disaster preparedness/management
* Set of fire-extinguisher
 |
| 1. Incidents and emergencies may include but are 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 are 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
 | 1. The following resources should be provided:
2. Access to relevant workplace where assessment can take place
3. 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/01/5/A

**Unit description**

This unit describes the competencies required by a Mechatronics technician to apply a wide range of engineering mathematics in their work. This includes applying algebraic functions, applying trigonometry and hyperbolic functions, Complex numbers, coordinate geometry, carrying out binomial expansion, calculus, Statistics, Vector theory, Matrix and Numerical methods in solving problems, Concepts of probability for work, performing commercial calculations and performing estimations, measurements and calculations of quantities

**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 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. The 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
 |
| 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
	4. Calculations are performed based on Laws of probability
	5. Calculation involving probability distributions, mathematical expectation sampling distributions are performed
 |
| 8. 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. Calculations 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 rates 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**  |
| Hyperbolic functions include but not limited to: | * + Sinh x
	+ Cosh x
	+ Cosec x
	+ Coth x
	+ Tanh x
	+ Sech x
 |
| Figures include but not limited to: | * + Triangles
	+ Squares
	+ Rectangles
	+ Circles
	+ Spheres
	+ Cylinders
	+ Cubes
	+ Polygons
	+ Cuboids
	+ Pyramids
 |
| Quantities 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 and 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. Applied Vector theory
	6. Applied Matrix
	7. Identified and selected measuring equipment
	8. Collected, Analyzed and presented data
	9. Applied Numerical methods
 |
| 1. Resource Implications
 | The following resources should be provided:2.1 Access to relevant workplace where assessment can take place2.2 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 4.1 Off the job4.2 on the job4.3 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 UNDERSTANDING OF ELECTRONICS

 **UNIT CODE:** ENG/OS/IC/CC/02/5/A

**UNIT DESCRIPTION**

This unit covers the competencies required to demonstrate understanding of electronics. It involves applying semiconductor theory, applying semiconductor diodes, demonstrating understanding of transistors, applying special semiconductor devices, performing rectification and applying digital electronics.

**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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| * 1. Apply semiconductor theory
 | * 1. Types of ***materials*** are established in line with semiconductor theory
	2. Semiconductor materials are identified as per their electrical conductivity properties
 |
| * 1. Apply semiconductor diodes
 | * 1. Types of diodes are identified as per their functionality
	2. ***Diode’s*** characteristics are determined as per their properties
	3. Forward and reverse bias characteristics are established as per the properties of the semiconductor material
 |
| 1. Demonstrate understanding of transistors
 | * 1. ***Transistors*** are identified as per their characteristics
	2. NPN and PNP are determined as per their operation
	3. P and N channels are identified as per their operation
	4. ***Biasing*** and determination of gain of transistors is performed as per their standard operating procedure
	5. Transistor configuration is performed as per their application
 |
| 1. Apply special semiconductor devices
 | * 1. Special semiconductor devices are identified as per their operation.
	2. Special semiconductors are applied as per their standard operating procedure.
	3. Types of special semiconductor devices are identified
 |
| 1. Perform rectification
 | * 1. Types of rectifiers are identified as per their functions
	2. Classes of rectifiers are identified as per their input voltage
	3. Applications of rectifiers are established
 |
| 1. Apply digital electronics
 | * 1. Number systems and their base conversions are determined as per standard operating procedure
	2. Number system representation are performed in line with standard operating procedure
	3. Boolean algebra is performed in accordance with established procedures
	4. ***Logic gates*** are determined in line with standard operating procedures
	5. Combination of logical circuits is performed as per in accordance with standard operating procedures
	6. Flip flops are identified as their functionality
 |

**RANGE**

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

| **Variable** | **Range** |
| --- | --- |
| 1. Materials may include but is not limited to:
 | * + Insulators
	+ Conductors
	+ Semiconductors
 |
| 1. Diodes may include but is not limited to
 | * Photo diodes
* Laser
* Zener diodes
* Light emitting diode
* Schottky diodes
 |
| 1. Transistors may include but is not limited to
 | * + BJTs
	+ FETs
 |
| 1. Biasing may include but is not limited to
 | * + Forward bias
	+ Reverse bias
 |
| 1. Logic gates may include but is not limited to
 | * + AND gates
	+ OR gates
	+ NOR gates
	+ NAND gates
	+ XOR gates
	+ XNOR gates
 |

**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:

* Amplifier construction
* Communications (verbal and written)
* Proficient in ICT
* Time management
* Analytical
* Decision making
* First aid
* Electronics biasing
* Problem solving
* Planning

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Health and safety;
* The environment (including waste disposal);
* Appropriate personal and protective equipment
* Appropriate use of tools and equipment
* Electronics operations
* Number systems and conversions
* Reporting of technical challenges
* Electronics biasing

**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. Identified different semiconductor material
	2. Demonstrated understanding in biasing of semiconductor materials
	3. Identified special semiconductor devices
	4. Performed forward and reverse biasing of semiconductor materials
	5. Identified different types of transistors
	6. Demonstrated understanding of rectification basing on standard operating procedures
	7. Determined number systems and their base conversions as per standard operating procedure
	8. Performed number system representation in line with standard operating procedure
	9. Performed Boolean algebraic calculation
	10. Determined logic gates in line with standard operating procedures
	11. Performed combination of logical circuits as per in accordance with standard operating procedures
	12. Identified flip flops as per their functionality
 |
| 1. Resource Implications
 | The following resources must be provided:* 1. Access to relevant workplace or appropriately simulated environment where assessment can take place
	2. Measuring equipment
	3. Materials relevant to the proposed activity or tasks
 |
| 1. Methods of Assessment
 | Competency may be assessed through:* 1. Oral test
	2. Written test
	3. Observation
	4. Practical demonstration
 |
| 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. |

# PERFORM WORKSHOP PROCESSES

**UNIT CODE:** ENG/OS/IC/CC/03/5/A

**UNIT DESCRIPTION**

This unit specifies the competencies required to perform workshop processes. It involves applying workshop safety, using workshop tools, instruments and equipment, preparing workshop tools and instrument for electrical installation practical, storing electrical tools and materials after practical, troubleshooting and repairing workshop tools and 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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1. Apply workshop safety | 1. Proper use of PPE is adhered to as per standard operating procedure
2. Workshop rules are followed as per standard operating procedure
3. Proper use of safety equipment is followed as per the manufacturer’s recommendations
4. First Aid procedures are adhered to
 |
| 1. Use workshop tools, instrument, and equipment
 | * 1. ***Workshop tools***, instruments and equipment are identified
	2. tools, instrument, and equipment are used as per the manufacture’s 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 e.g.
 | * 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 practical’s 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 practical’s
 | * 1. Tools are checked against the issuing list after practical’s
	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**

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. Workshop tools may include but not limited to:
 | * + Pliers
	+ Hacksaws
	+ Hammer
	+ Spirit levels
	+ Phase Tester
	+ Side cutters
 |

**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:

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

**Required knowledge**

The individual needs to demonstrate knowledge of:

* + Health and safety
	+ The environment (including waste disposal)
	+ Appropriate personal and protective equipment
	+ Appropriate use of service manual
	+ The legal and statutory requirements relating to electrical Workshop operation activities
	+ The manufacturer's manual about the operation of various workshop tools and instrument
	+ Faults troubleshooting
	+ Fault identification and diagnosis
	+ Appropriate use of tools and equipment
	+ Repairing, modifying, or replacing defective parts or components.
	+ Reporting of technical challenges

**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
 |
| 1. Resource Implications
 | The following resources must be provided:1. Access to relevant workplace or appropriately simulated environment where assessment can take place
2. Measuring equipment
3. Materials relevant to the proposed activity or tasks
 |
| 1. Methods of Assessment
 | Competency may be assessed through:* 1. Oral test
	2. Observation
	3. Practical demonstration
 |
| 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. |

# APPLY ELECTRICAL PRINCIPLES

**UNIT CODE:** ENG/OS/IC/CC/04/5/A

**UNIT DESCRIPTION**

This unit specifies the competencies required to apply electrical principles. It involves using the concept of basic electrical quantities, using the concepts of D.C and A.C circuits in electrical installation, using basic electrical machine, ddemonstrating understanding of three phase power supply, using power factor in electrical installation, using earthing in electrical installations, applying lightning protection measures, applying electromagnetic field theory, applying electrodynamics, applying energy and momentum in electromagnetic field, applying transient in electrical circuit analysis, using two port network and demonstrating 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
 |
| * + 1. 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
 |
| 1. Use of basic electrical machine
 | * 1. Types of various electrical machines are identified
	2. Single phase and three phase motor starting methods are performed
	3. DC motor starting methods are performed
	4. Calculations involving single phase and three phase AC and DC Motors are performed
	5. Calculations involving single and three phase AC and DC transformers are performed
	6. Calculations involving single and three phase generators are performed
	7. Special machines are identified
	8. Calculations involving special machines are performed
	9. Calculations involving Electric Drives are performed
 |
| 1. Demonstrate understanding of three phase power supply
 | * 1. Connections of three phase power supply are performed as per the standard operating procedure
	2. Calculations involving three phase power supply connections are performed
	3. Measurements of three phase power supply is performed
	4. Interconnections of three phase power supply are performed as per the nature of the load.
 |
| 1. 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
 |
| 1. Use of earthing in Electrical installations
 | * 1. Earthing types are identified
	2. Earthing points on Electrical installation are identified
	3. Calculation involved in determining the earthing type is performed
	4. Test on an earthing system is performed in line with the IEE regulations
 |
| 1. 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
 |
| 1. 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. Behaviours and effects of Electromagnetic waves are established
 |
| 1. Apply Electrodynamics
 | * 1. Electrostatics terms are identified
	2. Magnetostatics terms are identified
	3. Electrodynamics laws are identified
 |
| 1. Apply Energy and Momentum in Electromagnetic field
 | * 1. Energy conservation theorem is identified
	2. Electromagnetic Energy flow is determined
 |
| 1. Apply transients in Electrical Circuit Analysis
 | * 1. Growth and decay in R-L-C circuits are determined
	2. Calculations involving Growth and decay in R-L-C are performed
 |
| 1. 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
 |
| 1. 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
 |
| 1. Resource Implications
 | The following resources should be provided: * 1. Access to relevant workplace or appropriately simulated environment where assessment can take place
	2. Measuring equipment
	3. Materials relevant to the proposed activity or tasks
 |
| 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. 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. |

# PREPARE AND INTERPRET TECHNICAL DRAWINGS

**UNIT CODE:** ENG/OS/IC/CC/05/5/A

**UNIT DESCRIPTION**

This unit covers the competencies required to prepare and interpret technical drawings. It involves using and maintaining drawing equipment and materials, producing plane geometry drawings, producing solid geometry drawings, producing orthographic drawings, and producing pictorial drawings, producing electrical drawings and applying CAD 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 italicised 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 legislations1.6 ***Personal Protective Equipment*** is used according to occupational safety and health regulations |
| 1. 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
	6. Freehand sketching of different types of geometric forms, tools, equipment, diagrams is conducted
 |
| 1. Produce solid geometry drawings
 | * 1. Drawings of patterns are interpreted according to standard conventions
	2. Patterns are developed in accordance with standard conventions
 |
| 1. Produce orthographic and pictorial drawings
 | * 1. Symbols and abbreviations are identified, and their meaning interpreted according to standard drawing conventions
	2. First and third angle orthographic drawings are interpreted and produced in accordance with the standard conventions
	3. Orthographic elevations are dimensioned in accordance with standard conventions
	4. Isometric drawings are interpreted and produced in accordance with standard conventions
	5. Assembly drawing is produced and interpreted in line with the operating standards
 |
| 1. Produce electrical drawings
 | * 1. Electrical symbols and abbreviations are identified, and their meaning interpreted according to BS 3939
	2. ***Electrical drawings*** are produced in accordance with BS 3939
 |
| 1. Apply CAD packages
 | * 1. CAD packages are selected according to task requirements
	2. CAD packages are applied in production of electrical drawings
 |

**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. 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. 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. Electrical drawings may include but is not limited to:
 | * Block
* Schematic
* Circuit
* line and 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
 |
| 1. Resource Implications
 | The following resources should be provided: * 1. Access to relevant workplace or appropriately simulated environment where assessment can take place
	2. Measuring equipment
	3. Materials relevant to the proposed activity or tasks
 |
| 1. Methods of Assessment
 | Competency may be assessed through:* 1. Practical tests
	2. Observation
 |
| 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. |

# CORE UNITS OF COMPETENCY

# PERFORM ELECTRICAL INSTALLATION

**UNIT CODE:** ENG/OS/IC/CR/01/5/A

**UNIT DESCRIPTION**

This unit specifies competencies required for performing electrical installation. It involves conducting site survey, performing system sizing, preparing working drawings, preparing list of tools equipment and materials, preparing installation work plan, establishing installation team, performing electrical installation, terminating electrical installation, inspecting and testing installation, preparing reports and commissioning the installation.

**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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1. Conduct site survey
 | * 1. The site is surveyed is performed in line with contract
	2. Conditions of the site are evaluated according tothe established procedures
	3. Installation route is identified as per the standard operating procedure
	4. Measurements are taken as per expected installation.
	5. Survey report is generated and shared with relevant parties according to the established procedures
 |
| 1. Perform system sizing
 | * 1. Type and size of protective devices is determined according to **IEE regulations**
	2. Cable sizes are calculated for the estimated loads in line with IEE regulations
	3. Solar energy conversions are performed as per standard operating procedures
	4. Solar energy system sizing is performed as per established procedures
	5. System sizes are recorded and shared as per ***established procedures***
 |
| 1. Prepare working drawings
 | * 1. Installation design is interpreted as per standard operating procedure
	2. Symbols and nomenclatures are applied in accordance with British Standards [BS 3939]
	3. Drawing tools are applied as per the expected task
	4. Components and their ratings are identified as per their applications
	5. Cable sizes and lengths are shown as per the design
	6. Power supply and distribution circuits are drawn in accordance with the design
	7. Phase balancing of the loads is performed according to the usage
	8. Cable routes are clearly indicated in line with design
	9. Working drawing is prepared as per the design and any deviations shared with relevant parties
 |
| 1. Prepare list of tools, equipment and materials.
 | * 1. Tools, equipment, and materials needed for the work are determined and list prepared as per established procedure
	2. Tools, equipment, and materials are checked for ***specifications*** and functionality as per the standard operating procedure
	3. Tools, equipment, and materials are assembled and stored in line with established procedure
 |
| 1. Prepare installation work plan
 | * 1. Installation drawing is acquired as per established procedure
	2. The scope of installation work is identified as per activities to be performed
	3. Work is undertaken as per the workplace procedures.
	4. Team members are identified according to the tasks
	5. ***Work schedule*** is prepared basing on the scope and the working drawing
	6. Type of permit to work is identified as per EPRA regulations
	7. Permits issuing bodies are identified in accordance to permits required for the work
	8. Permit to work form is filled and submitted to the responsible body as per standard operating procedures
 |
| 1. Establish installation team
 | * 1. Communication protocol is designed and distributed among the team members as per workplace communication hierarchy
	2. Responsibilities are established and distributed among the team members in accordance with their expertise
	3. Team familiarization is performed according to the established procedure
 |
| 1. Perform installation
 | * 1. Installation procedures and technical standards are applied in line with established standards
	2. Working drawing is implemented as per installation requirements
	3. Safety procedures are adhered to for each activity in accordance to OSHA regulations
	4. Cables, conductors, conduits, enclosures, and support systems are installed as per the working drawing
	5. Bell and alarm circuits are installed as per system requirements
	6. Cables are drawn-in in line with standard operating procedures.
	7. Solar installation components are identified in with system requirements
	8. Number and size of cables are laid in a conduit as per the IEE regulations
	9. Earthing and protection is performed in line with standard operating procedure
 |
| 1. Terminate installation
 | * 1. Cable lugging is performed as per the standards operating procedure.
	2. Cables are terminated in accordance with IEE regulations
	3. Labelling of cables is performed basing on the complexity of the job.
 |
| 1. Inspect and test electrical installation
 | * 1. Type of tests are identified as per nature of installation
	2. Test is performed in line the IEE regulations
	3. Firmness of the installation is established as per standard operating procedure
	4. Continuity test is performed as per standard operating procedure
	5. Ring circuit test is performed as per the standard operating procedure
	6. Earth continuity test is performed in accordance IEE regulations
	7. Short circuit test is performed in accordance with IEE regulation
	8. Earth resistance test is performed in line with IEE regulations
	9. Open circuit test is performed as per standard operating procedure
 |
| 1. Commission and prepare installation reports
 | * 1. User training is performed in accordance with system functionality
	2. Installation report is prepared in line with standard operating procedures
	3. Installation report is documented and shared with relevant parties based on the contract
	4. Commissioning of the installed system is performed as per standard operating procedure
	5. Commissioning of the installed system is performed in consideration of safety standards
 |

**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. IEE regulations may include but not limited to:
 | * 17th Edition
 |
| 1. Specifications may include but not limited to:
 | * + Tolerance/ range
	+ Make / model
	+ Size
	+ Class
 |
| 1. Work schedule may include but not limited to:
 | * + Gantt chart
	+ Block
 |

**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:

* Communications (verbal and written)
* Proficient in electrical principles
* Time management
* Problem solving
* • Negotiation
* Decision making
* First aid
* Report writing
* Planning

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Health and safety;
* Environment (including waste disposal);
* Appropriate personal protective equipment (PPE).
* Materials management
* The importance of documentation and keeping records
* The legal requirements relating to electrical installations
* The manufacturer's warranty requirements relating to electrical installation systems and related components
* Decision making
* First aid
* Financial statements
* The importance of using the correct sources of technical information.
* Interpreting circuits, drawings, specifications and instructions
* Preparing work plans in accordance with legislative and regulatory requirements and standard operating procedures and health and safety requirements
* Contractual agreements
* Importance of contractual agreements
* Necessary insurance and policies including security bonds, performance bonds, contractors all risks
* Insurance of contractor work

**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 work health and safety procedures as per OSHA regulations
	2. Interpreted the design and prepared a working drawing in line with standard operating procedure
	3. Determined types and sizes of materials and equipment and protective devices as per installation requirements
	4. Survey report is generated and shared with the relevant parties as per the contract
	5. Measurement are taken at the site in line with standard operating procedure
	6. Installation planning was performed as per the scope of the work
	7. Cables and accessories were installed as per the IEE regulation
	8. Cables were terminated as per the IEE regulation
	9. Installation was tested and results documented as standard operating procedures
	10. Performed solar energy conversions as per standard operating procedure
 |
| 1. Resource Implications
 | The following resources should be provided: * 1. Access to relevant workplace or appropriately simulated environment where assessment can take place
	2. Measuring equipment
	3. Materials relevant to the proposed activity or tasks
 |
| 1. Methods of Assessment
 | Competency may be assessed through:3.1 Observation 3.2 Oral questioning3.3 Practical demonstration |
| 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. |

# INSTALL CONTROL SYSTEMS

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

**UNIT DESCRIPTION**

This unit covers competencies required to install control system. It involves preparing working drawings, preparing a list of tools, equipment and materials, configuring and mounting control system components, performing wiring of control system components, terminating wiring on control system components, testing the installed control system control system, commissioning and documenting installation report.

**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 italicised*** terms ***are elaborated in the Range)*** |
| --- | --- |
| 1. Prepare working drawings
 | * 1. Installation design is interpreted as per standard operating procedure
	2. Symbols and nomenclatures are applied in accordance with British Standards [BS 3939]
	3. Drawing tools are applied as per the expected task
	4. Components and their ratings are identified as per their applications
	5. Cable sizes and lengths are shown as per the design
	6. Power supply and distribution circuits are drawn in accordance with the design
	7. Phase balancing of the loads is performed according to the usage
	8. Cable routes are clearly indicated in line with design
	9. Working drawing is prepared as per the design and any deviations shared with relevant parties
 |
| 1. Prepare a list of tools, equipment, and materials
 | * 1. Tools, equipment, and materials are identified as per the tasks to be carried out.
	2. Tools, equipment, and materials are assembled basing on their functionality
	3. Tools, equipment, and materials are configured in consideration of system’s installation requirements
	4. Tools, equipment, and materials are assembled in consideration of system parameters
 |
| 1. Configure and mount control system components
 | * 1. ***System components*** are labelled in line with their functions
	2. System components are mounted as per the system design
	3. System components are mounted basing on standard operating procedures
	4. Control panels ***enclosures*** and locations are determined as per established standards
	5. Components are mounted in line with system requirements
 |
| 1. Perform wiring of control system components
 | * 1. Wiring of system components is performed in adherence to IEE regulations
	2. Wiring of components is performed in line with standard operating procedure.
	3. Wiring of electronic components is performed as per the system design
	4. Cable types and rating are selected in accordance with system components’ power rating and functionality (power cables and signal cables)
 |
| 1. Terminate control system wiring
 | * 1. ***Termination methods*** are identified basing on load sizes
	2. Wiring is terminated in adherence to IEE regulations
	3. Wiring termination is performed in consideration of OSHA regulation
	4. Wiring labelling is performed in accordance with standard operating procedures
 |
| 1. Test the installed control system
 | * 1. System components are tested in line with their power ratings
	2. System components are tested based on their functionality
	3. System components are tested in line with manufacturer’s manuals
	4. Testing the system is performed as per system functionality
 |
| 1. Commission the system and document installation report.
 | * 1. Installation report is prepared in line with standard operating procedures
	2. Installation report is documented and shared with relevant parties based on the contract
	3. User training is performed in accordance with system functionality
	4. Commissioning of the installed system is performed as per standard operating procedure
	5. Commissioning of the installed system is performed in consideration of safety standards
 |

**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. System components may include but not limited to
 | * Power supply
* SCADA
* HMI
* PLC
* Input-output modules
* Rails
* Connectors
* Cables
* Ferrule
* Lugs
* Relay
 |
| 1. Enclosure may include but not limited to
 | * Panels and distribution boards
* IP classes
 |

**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:

* Operate test equipment and interpret results
* Metering
* Read and understanding plans and symbols
* Drawing plans
* Using of CAD
* Computer skills
* Problem solving & decision making
* Analytical
* Troubleshooting

**Required knowledge**

The individual needs to demonstrate knowledge of:

* + Control system components
	+ Electrical wiring
	+ Electrical design software
	+ MS Word & Excel
	+ Network Components and devices•
	+ Color coding
	+ Use of electrical & mechanical tools
	+ Troubleshooting
	+ Electrical power distribution
	+ Power protection
	+ Testing techniques
	+ Measurement
	+ Electrical standards
* Work Ethics
* Project management
* Parameters for normal/abnormal operation of equipment for climate zones
* Knowledge of principles of machine control system
* Research effectively on the internet (including old equipment)
* Environmental regulations
* Electrical principles
* Electrical codes
* Life cycle costing for energy systems
* OSHA, WSHA, and industry safety procedures and regulations

**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. Prepared a list of tools, equipment and materials basing on their functionality
	2. Mounted control system components in accordance to standard operating procedures
	3. Performed mounting of control system components as per IEE regulations
	4. Terminated control system wiring in regard to IEE regulations
	5. Tested the system components as per system functionality
	6. Prepared and documented the installation report in line with standard operating procedures
	7. Performed user training and commissioned the control system installation as per the contract
 |
| 1. Resource Implications
 | The following resources must 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 may be assessed through:3.1 Observation 3.2 Oral questioning3.3 Practical demonstration3.4 Written examination |
| 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. |

# PERFORM INDUSTRIAL MEASUREMENTS AND INSTRUMENTATION

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

**UNIT DESCRIPTION**

This unit covers the competencies required to perform industrial measurements and instrumentation. It involves demonstrating understanding of measurements, applying analogue instruments, applying electromechanical instruments, applying digital instruments, measuring of electrical and physical quantities, applying waveform in analyzing instruments, applying sensors and transducers and calibrating instruments.

**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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1. Demonstrate understanding of measurements
 | * 1. Units, dimensions, and standards are identified in accordance with engineering practices
	2. Conversions of units is performed in line with standard operating procedures
	3. Dimensions of various quantities are determined based on their applications
	4. Measurement standards are identified as per their applications
	5. Measurement errors are determined based on standard operating procedures
	6. Accuracy, precision, resolution, sensitivity, and significant figures are determined in line with standard operating procedures
	7. Measurement of speed is performed in line with standard operating procedure
	8. Measurement of pressure is performed as per standard operating procedure
	9. Level measurement is performed in accordance with standard operating procedure
	10. Temperature measurement is performed as per standard operating procedure
	11. Viscosity, humidity, and moisture measurement are performed as per established procedure
	12. Pneumatic measurement systems are identified as per standard operating procedure.
 |
| 1. Apply analogue instruments
 | * 1. Analogue meters are classified based on their functionality
	2. Analogue meters are applied in line with standard operating procedures
	3. Errors are determined based on the instruments and component error combinations
	4. Errors are analysed as per standard operating procedures
	5. Performance characteristics are determined based on standard operating procedures
	6. Signal conditioning is performed in line with standard operating procedures
	7. Signal processing is performed as per standard operating procedures
	8. Data presentation is performed in line with established procedures
 |
| 1. Apply electromechanical instruments
 | * 1. Permanent magnet moving coil (PMMC) instruments are applied as per standard operating procedures
	2. PMMC is applied in accordance with their application in the galvanometers, dc ammeters, dc voltmeters, ac ammeters and ac voltmeters
	3. Iron moving instruments are applied as per standard operating procedure
	4. Internal resistances for ammeters and voltmeters are determined in line with established procedures
	5. Types of electromechanical instruments are applied basing on their function and range applications
	6. Electrodynamics instruments are applied in consideration of their applications as voltmeter, ammeter, and wattmeter
	7. Energy meters are applied as per standard operating procedure
 |
| 1. Apply digital instruments
 | * 1. Demonstrate understanding of logic gates based on their applications
	2. Demonstrate understanding of digital counting as per standard operating procedures
	3. Demonstrate understanding of flip flops circuits basing on their applications
	4. Demonstrate understanding of LEDs, LCDs, & seven segment displays, encoders, as per standard operating procedure
	5. Analogue to digital converters is determined based on their applications
	6. Digital to analogue converters are determined based on based on applications
	7. Digital instruments accuracy and resolutions are determined as per their functionalities.
	8. Signal conditioning is performed in line with standard operating procedures
	9. Signal processing is performed as per standard operating procedures
	10. Data presentation is performed in line with established procedures
 |
| 1. Measure electrical and physical quantities
 | * 1. Identify methods of resistance measurements in regard to standard operating procedures
	2. Wheatstone bridge resistance measurement is performed as per standard operating procedures
	3. High resistance measurement is performed as per standard operating procedures
	4. RC, RL and RLC series and parallel circuits are identified as per standard operating procedure
	5. Q factor is determined based on standard operating procedure
	6. Types of AC and DC bridges are determined in regard to established procedures
	7. Apply digital multimeters as per standard operating procedures
	8. Apply the Q meters in regard to established procedures
	9. Physical quantities are measured according as per standard operating procedures
 |
| 1. Apply waveform in analysing instruments
 | * 1. Analogue and digital oscilloscope are identified as per standard operating procedure
	2. Operation of oscilloscopes is performed based on its applications
	3. Oscilloscope specifications are determined in accordance to scope of measurements to be performed
	4. Special oscilloscope is applied as per standard operating procedures
 |
| 1. Apply sensors and transducers
 | * 1. Sensors and transducers are identified in line with their applications
	2. Sensors and transducers are classified as per their functionality
	3. Sensors and transducers are determined in line with their specifications
	4. Signal processors are identified based on their processing ratings
	5. Signal processors are identified in line with their applications
	6. Data presentation methods are determined based on the nature of the output signal displays
 |
| 1. Calibrate instruments
 | * 1. ***Digital and analogue instruments*** are calibrated as per standard procedure
	2. Instruments are calibrated in regard to their deflection range
	3. Electromechanical and electronic ohmmeter are calibrated in line with standard operating procedures
	4. Wattmeter, voltmeter and ammeter is calibrated as per standard operating procedure
	5. Standard calibrating instruments are identified based on their operating parameters
 |

**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. Digital and analogue instruments may include but not limited to:
 | * Voltmeter
* Ammeter
* Ohmmeter
* Wattmeter
* Oscilloscope
* Q meter
 |

**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:

* Operate test equipment and interpret results
* Troubleshooting
* Read and understand Symbols and schematics
* Metering and interconnection

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Digital and analogue instruments
* Analogue electronics
* Digital electronics
* Physical quantities
* Measurement
* Instrumentation and calibration
* Sensors and transducers
* Engineering principles
* OSHA, WSHA, and industry safety procedures and regulations

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Identified units, dimensions and standards in line with engineering practices
	2. Determined dimensions of various quantities in line with their applications
	3. Classified analogue meters as per their functionality
	4. Identified errors in analogue meters as per effect on measurements
	5. Applied the permanent- magnet moving coil (PPMC) instrument as per standard operating procedures
	6. Applied PPMC based on the application in the galvanometers, dc ammeters, dc voltmeters, ac ammeters and ac voltmeters
	7. Applied electrodynamics instruments as per their functionality
	8. Demonstrated understanding of logic gates in regard to their application
	9. Demonstrated understanding of latches registers and counters.
	10. Demonstrated understanding of flip flops in line with their applications
	11. Demonstrated understanding of LEDs, LCDs, & seven segment displays, encoders, decoders, duplex and optical fibre based on standard operating procedure
	12. Determined analogue to digital converters are determined as per their applications
	13. Identified RLC, RC and RL series and parallel circuits in line with standard operating procedure
	14. Determined Q factor using standard operating procedure
	15. Determined types of AC and DC bridges using established procedures
	16. Identified analogue and digital oscilloscope based on standard operating procedure
	17. Performed maintenance of oscilloscopes in line with standard operating procedures
	18. Performed operation of oscilloscopes as per its applications
	19. Determined oscilloscope specifications based on the scope of measurements to be performed
	20. Identified sensors and transducers in line with their applications
	21. Classified sensors and transducers based on their functionality
	22. Determined sensors and transducers in line with their specifications
	23. Identified signal processors in line with their applications
	24. Determined data presentation methods basing on the nature of the output signal displays
 |
| 1. Resource Implications
 | The following resources must 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 may be assessed through:* 1. Oral questioning
	2. Practical demonstration
	3. Observation
	4. Written tests
 |
| 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. |

# MAINTAIN INSTRUMENTATION, CONTROL AND TRANSMISSION SYSTEMS

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

**UNIT DESCRIPTION**

This unit covers competencies required to maintain instrumentation, control and transmission systems. It involves preparing maintenance schedule, inspecting and testing instrumentation, control and transmission system, preparing a list of tools, equipment and materials, performing maintenance activities, conducting tests on maintained system and documenting maintenance records.

**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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1. Prepare maintenance schedule
 | * 1. Systems to be maintained are identified as per standard operating procedure
	2. Scope and type of maintenance to be carried out is determined based on the system maintenance requirements
	3. Maintenance checklist is prepared in line with standard operating procedure
	4. Manufacturer’s manuals are assembled in accordance to system components
	5. Maintenance team is identified and assembled as per the expertise required
	6. Maintenance work plan is developed in regard to maintenance activities to be performed.
 |
| 1. Inspect and test instrumentation, control, and transmission systems
 | * 1. Controller functions, instrumentation, transmission systems and process controls are identified based on standard operating procedures
	2. System diagnostics are performed according to standard operating procedure
	3. Equipment is isolated and make-safe procedures performed in line with manufactures manuals
	4. Controller deviations, faults, and errors are identified according to manufactures specifications
	5. Process upset conditions and limitations are identified in line with standard operation procedure
 |
| 1. Prepare a list of maintenance tools, equipment, and materials
 | * 1. Maintenance tools and equipment are identified in regard to maintenance activities to be performed
	2. A list of tools, equipment and materials are prepared in line with established procedure
	3. Tools and equipment are checked for specifications and functionality as per operating procedures
	4. Tools and equipment are calibrated in line with standard operating procedure
 |
| 1. Perform maintenance activities
 | * 1. Greasing and oiling is performed as per standard operating procedures
	2. Faulty controllers, transmission ***system components*** are replaced according to standard operating procedure
	3. Controller parameters are tuned to varying process conditions according to manufacturers’ procedure and specifications
	4. Software and firmware are updated/upgraded according to manufactures’ procedure
	5. Controller is calibrated according to manufacturers’ specifications
	6. Controller to process system is restored in line with standard operating procedures
	7. Backup documentation is compiled according to workplace procedure
	8. Computer programs and software related to SACs, DCS, PLCs and HMIs functions are updated in adherence to system functionality
	9. Program and configuration are backed-up and restored according standard operating procedures
	10. I/O are forced, disabled, and bypassed in line with standard operating procedures
	11. Transmission and control system components are shut down and started up according to manufactures specifications
	12. Software and firmware are upgraded according to manufactures manual
	13. Program modifications is conducted in line with system functionality
	14. Devices are replaced according to system requirements.
	15. Backup batteries are replaced according to established procedure
	16. Fans and environmental filters are cleaned as per standard operating procedure
 |
| 1. Conduct system tests
 | * 1. Type of tests to be carried out are identified in line with maintenance activities
	2. Components to be tested are identified based on the system functionality
	3. Repaired/replaced components are tested in accordance to manufacturer’s manuals
	4. Test-running the system is performed based on the system functionality
	5. Test results are recorded as per standard operating procedures
 |
| 1. Document maintenance records
 | * 1. Maintenance checklist is documented in regard to standard operating procedure
	2. Maintenance report is prepared as per standard operating procedure
	3. Backup documentation is compiled according to standard operating procedures
	4. Maintenance report is shared among parties based on the contract
 |

**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. System components may include but not limited to:
 | * Power supply
* Valves
* Actuators
* Cylinders
* Tubing
* Gauges
* Motors
* Pumps
* Fittings
 |

**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:

* Communications (verbal and written)
* Computer literacy
* Analytical skills
* Decision making
* Report writing
* Time management
* Faults troubleshooting
* Problem solving
* Planning

**Required knowledge**

The individual needs to demonstrate knowledge of:

* + Troubleshooting techniques
	+ Repair/replacing of system components techniques
	+ Causes of system failures
	+ Knowledge in electrical principles
	+ Knowledge in mechanical principles
	+ Electrical safety and precautious measures
	+ Electrical shock prevention measures
	+ Knowledge in engineering mathematics
	+ Performance monitoring techniques
* Electrical principles
* Mechanical principles
* Physics

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Identified systems to be maintained as per standard operating procedure
	2. Determined scope and type of maintenance to be carried out based on the system maintenance requirements
	3. Prepared maintenance checklist as per standard operating procedure
	4. Assembled manufacturer’s manuals in line with system to be maintained
	5. Inspected system and equipment as per established procedure
	6. Identified main isolation points in accordance to system configuration
	7. Identified components and equipment and tested based on established procedures
	8. Identified maintenance tools and equipment as per maintenance activities to be performed
	9. Checked tools and equipment for specifications and functionality as per operating procedures
	10. Identified system components to be repaired/replaced as per standard operating procedure
	11. Carried out maintenance activities in line with OSHA standards
	12. Disposed waste materials in line with EHS regulations
	13. Performed cleaning, soldering and tightening of components as per standard operating procedure
	14. Identified components to be tested as per system functionality
	15. Tested repaired/replaced components as per manufacturer’s manuals
	16. Recorded test results as per standard operating procedures
 |
| 1. Resource Implications
 | The following resources must 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 may be assessed through:* 1. Oral questioning
	2. Practical demonstration
	3. Observation
	4. Written tests
 |
| 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. |

# INSTALL TRANSMISSION SYSTEMS

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

**UNIT DESCRIPTION**

This unit covers the competencies required to install transmission systems. It involves preparing working drawings, preparing a list of tools, equipment and materials, mounting transmission system components, performing wiring, tubing and fitting of transmission system components, testing installed transmission system and commissioning the system and documenting installation report.

**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 italicised terms are elaborated in the Range)*** |
| --- | --- |
| 1.Prepare working drawings | 1. Installation design is interpreted as per standard operating procedure
2. Symbols and nomenclatures are applied in accordance with British Standards [BS 3939]
3. Drawing tools are applied as per the expected task
4. Components and their ratings are identified as per their applications
5. Cable sizes and lengths are shown as per the design
6. Power supply and distribution circuits are drawn in accordance with the design
7. Phase balancing of the loads is performed according to the usage
8. Cable routes are clearly indicated in line with design
9. Working drawing is prepared as per the design and any deviations shared with relevant parties
 |
| 1. Prepare a list of tools, equipment, and materials
 | 1. Tools, equipment and materials are identified as per the tasks to be carried out
2. Tools, equipment and materials are assembled basing on their functionality
3. Tools, equipment and materials are configured in consideration of system’s installation requirements
4. Tools, equipment and materials are assembled in consideration of system parameters
 |
| 1. Mount transmission system components
 | * 1. Air compressor components are identified as per standard operating procedure
	2. Air compressors are mounted in line standard operating procedure
	3. Air compressors are mounted as per system functionality
	4. Air compressors are mounted as per manufacturer’s manuals
	5. Pneumatic cylinder components are identified in line with standard operating procedure
	6. Pneumatic valve components are identified as per standard operating procedure
	7. Pneumatic cylinders are mounted in line with system requirements
	8. Pneumatic valves are installed as per system requirements
	9. Pneumatic cylinders and valves are installed in line with standard operating procedure
	10. Pneumatic fittings and tubing are mounted as per standard operating procedure
	11. Pneumatic actuators are mounted as per standard operating procedure
	12. Sensors and transducers are mounted as per system requirements
	13. Pressure gauges are mounted in line with standard operating procedures
	14. Hydraulic fluid reservoir is mounted based on system design
	15. Hydraulic motors are mounted as standard operating procedures
	16. Hydraulic fluid reservoirs are mounted in adherence to safety measures
	17. Hydraulic pump components are identified in line with standard operating procedure
	18. Hydraulic pumps are installed based on system design
	19. Hydraulic pumps are installed as per standard operating procedure
	20. Hydraulic valves are mounted as per system requirements
	21. Hydraulic actuators are mounted as per standard operating procedures
	22. Hydraulic cylinders are mounted based on system require
	23. Hydraulic system components are tested and configured in line standard operating procedure
	24. Electrical transmission system components are mounted as per standard operating procedure
	25. Electrical transmission system components are mounted in line with system requirements
	26. Electrical transmission system components are mounted in consideration of manufacture’s manuals
	27. Electromechanical transmission system components are mounted as per standard operating procedure
	28. Electromechanical transmission system components are mounted in line with system requirements
	29. Electromechanical transmission system components are mounted in consideration of manufacture’s manuals
 |
| 1. Perform wiring, tubing, and fitting of transmission system components
 | * 1. Wiring transmission system components is performed in adherence to IEE regulations
	2. Wiring of components is performed in line with standard operating procedure.
	3. Wiring of electronic components is performed as per the system design
	4. Cable types and rating are selected in accordance with system components’ power rating and functionality (power cables and signal cables)
	5. Tubing is performed in line with standard operating procedure.
	6. Tubing is performed as per system design
	7. Fitting is performed as per standard operating procedure
	8. Fitting is performed in consideration of safety standards
	9. Fitting is performed as per system design
 |
| 1. Test the installed transmission system
 | * 1. Transmission system is configured basing on the expected system functional
	2. . System components are tested in line with their power ratings
	3. System components are tested based on their functionality
	4. System components are tested in line with manufacturer’s manuals
	5. Testing the system is performed as per system functionality
	6. Transmission system is configured in line with standard operating procedure
	7. Configuration is performed based on the expected system functionality
 |
| 1. Commission the system and document installation report.
 | 1. Installation report is prepared in line with standard operating procedures
2. Installation report is documented and shared with relevant parties based on the contract
3. User training is performed in accordance with system functionality
4. Commissioning of the installed system is performed as per standard operating procedure
5. Commissioning of the installed system is performed in consideration of safety standards
 |

**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. System components may include but not limited to:
 | * Power supply
* Valves
* Actuators
* Cylinders
* Tubing
* Gauges
* Motors
* Pumps

Fittings |
| 1. Protection devices may include but not limited to:
 | * Lightening arresters
* Earth rods
* Valves
* Fuses (AC & DC)
* Relays
* Isolators
 |

**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
* Team Work
* Problem solving
* Planning and Organising
* Self-management
* Safety awareness

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Types of hydraulic pumps, cylinders, valaves, actuators supplied by various manufacturers and the differences in their architecture and capabilities
* Types of components such as power supply
* Fitting methods
* Communication networks and protocols
* Installation conditions such as temperature, vibrations and dust
* Manufacturers’ specifications and recommendations
* Configuration parameters
* Types of tubing
* Transmission medium
* Access and security levels
* Licensing and service contract requirements
* Controlled process
* Interaction with process
* Software and hardware limitations
* Use of original transmission components
* Obsolescence issues
* Service bulletins and alerts
* Cause and effects of forcing and bypassing I/Os
* Data types such as binary, integer and floating point

**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. Assembled tools, equipment and materials basing on their functionality
	2. Configured tools, equipment and materials in consideration of system’s installation requirements
	3. Assembled tools, equipment and materials in consideration of system parameters
	4. Mounted pneumatic fittings and tubing as per standard operating procedure
	5. Mounted pneumatic actuators as per standard operating procedure
	6. Mounted sensors and transducers as per system requirements
	7. Mounted hydraulic fluid reservoir based on system design
	8. Mounted hydraulic pumps based on system design
	9. Mounted hydraulic valves are as per system requirement
	10. Performed wiring of electronic components as per the system design
	11. Selected cable types and rating in accordance with system components’ power rating and functionality (power cables and signal cables)
	12. Performed tubing as per system design
	13. Performed fitting as per standard operating procedure
	14. Tested system components in line with their power ratings
	15. Tested system components based on their functionality
	16. Tested system components in line with manufacturer’s manuals
	17. Performed user training in accordance with system functionality
 |
| 1. Resource Implications
 | The following resources must 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 may be assessed through:* 1. Observation with the help of check list
	2. Practical demonstrations
	3. Oral Questioning
 |
| 1. Context of Assessment
 | Competency may be assessed1. 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. |