

**THE REPUBLIC OF KENYA**

**NATIONAL OCCUPATIONAL STANDARDS**

**FOR**

**MECHATRONIC CRAFTPERSON**

**LEVEL 5**



TVET CDACC

P.O BOX 15745-00100

NAIROBI

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**Council Secretary/CEO**

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

**P.O. Box 15745–00100**

**Nairobi, Kenya**

**Email:** [**info@tvetcdacc.go.ke**](mailto:info@tvetcdacc.go.ke)

# FOREWORD

The provision of quality education and training is fundamental to the Government’s overall strategy for social economic development. Quality education and training will contribute to achievement of Kenya’s development blueprint, Vision 2030 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 of Kenya 2010 and this resulted to the formulation of the Policy Framework for Reforming Education and Training (Sessional Paper No. 4 of 2016). A key feature of this policy is the radical change in the design and delivery of the TVET training.

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 were developed for developing a competency-based curriculum for Mechatronic Technology Level 5. These Occupational Standards will also be the bases 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 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. 4 of 2016 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 labor force.

The TVET Curriculum Development, Assessment and Certification Council (TVET CDACC), in conjunction with Mechatronic Sector Skills Advisory Committee (SSAC have developed these Occupational Standards for Mechatronic technicians. These standards will be the bases for development of competency-based curriculum for Mechatronic Technology 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, Mechatronic 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 Mechatronic 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**

**MECHATRONIC SECTOR SKILLS ADVISORY COMMITTEE**

# ABBREVATIONS AND ACRONYMS

A.C: Alternating Current

CAD: Computer Aided Design

CBET: Competency Based Education and Training

CDACC: Curriculum Development, Assessment and Certification Council

D.C: Direct Current

EIA: Environmental Impact Assessment

EMS: Environmental Management System

I/O: Input/output

ICT: Information communication technology

OSH: Occupational Safety and Health

OSHA: Occupational, Health and Safety Act

PLC: Programmable Logic Control

PPE: Personal Protective Equipment

SSAC: Sector Skill Advisory Committee

TVET: Technical and Vocational Education and Training

VSD: Variable Speed Drive

# **KEY TO UNIT CODE**

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

Industry or sector

Occupational Standards

Occupational area

Type of competency

Competency number

Competency level

Version control

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# OVERVIEW

The units of competency comprising Mechatronic Craftsperson level 5 entails installing mechatronic systems, maintaining electro-mechanical systems, mechatronic systems instrumentation and control, operating robotic and automated systems, pneumatic and hydraulic systems and programmable logic control (PLC) systems.

|  |  |
| --- | --- |
| **BASIC UNITS OF COMPETENCY** | |
| **Unit of Competency Code** | **Units of competency** |
| **ENG/OS/MC/BC/01/5/A** | Communication skills |
| **ENG/OS/MC/BC/02/5/A** | Digital literacy |
| **ENG/OS/MC/BC/03/5/A** | Entrepreneurial skills |
| **ENG/OS/MC/BC/04/5/A** | Employability skills |
| **ENG/OS/MC/BC/05/5/A** | Environmental literacy |
| **ENG/OS/MC/BC/06/5/A** | Occupational health and safety |
| **COMMON UNITS OF COMPETENCY** | |
| **ENG/OS/MC/CC/01/5/A** | Technical drawing |
| **ENG/OS/MC/CC/02/5/A** | Applying engineering mathematics |
| **ENG/OS/MC/CC/03/5/A** | Applying electrical and electronics principles |
| **ENG/OS/MC/CC/04/5/A** | Workshop processes and practices |
| **CORE UNITS OF COMPETENCY** | |
| **ENG/OS/MC/CR/01/5/A** | Installing mechatronic systems |
| **ENG/OS/MC/CR/02/5/A** | Maintaining electro-mechanical systems |
| **ENG/OS/MC/CR/03/5/A** | Mechatronic systems instrumentation and control |
| **ENG/OS/MC/CR/04/5/A** | Operating robotic and automated systems |
| **ENG/OS/MC/CR/05/5/A** | Operating pneumatic and hydraulic systems |
| **ENG/OS/MC/CR/06/5/A** | Operating programmable logic control (PLC) systems |

# BASIC UNITS OF COMPETENCY

## DEMONSTRATE COMMUNICATION SKILLS

**UNIT CODE:** ENG/OS/MC/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 assessable statements 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 are 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/MC/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 build 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 | The following resources should be provided:   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/MC/BC/03/5/A

**UNIT DESCRIPTION**

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

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT** | **PERFORMANCE CRITERIA** |
| 1. Demonstrate understanding of an Entrepreneur | 1. Entrepreneurs and 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.

|  |  |
| --- | --- |
| **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 | The following resources should be provided:   1. Access to relevant workplace where assessment can take place 2. Appropriately simulated environment where assessment can take place |
| 1. Methods of Assessment | Competency may be assessed through:   1. 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/MC/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/MC/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/MC/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. ***Hazards*** in the workplace are identified ***based their indicators*** 2. Risks and hazards are evaluated based on legal requirements. 3. ***OSH concerns*** raised by workers are addressed as per legal requirements. |
| 1. Control OSH hazards | 1. Hazard prevention ***and control measures*** are implemented as per legal requirement. 2. Risk assessment is conductedand a risk matrix developed based on likely impact. 3. ***Contingency measures***, including ***emergency procedures*** during workplace ***incidents and emergencies*** are recognized and established in accordance with organization procedures. |
| 1. Implement OSH programs | 1. Company OSH program are identified, evaluated and reviewed based on legal requirements. 2. Company OSH programs are implemented as per legal requirements. 3. Workers are capacity built on OSH standards and procedures as per legal requirements 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 | The following resources should be provided:   1. Access to relevant workplace where assessment can take place 2. Appropriately simulated environment where assessment can take place |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Observation 2. Oral questioning 3. Written test 4. Portfolio of Evidence 5. Interview 6. Third party report |
| 1. Context of Assessment | Competency may be assessed:   1. On-the-job 2. Off-the –job 3. During Industrial attachment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

# COMMON UNITS OF COMPETENCY

## PREPARE AND INTERPRET TECHNICAL DRAWINGS

**UNIT CODE:** ENG/OS/MC/CC/01/5/A

**UNIT DESCRIPTION**

This unit covers the competencies required to prepare and interpret technical drawings by a Mechatronic Craftsperson. It involves competencies to select, use and maintain drawing equipment and materials. It also involves producing plain geometry drawings, solid geometry drawings, pictorial and orthographic drawings of components and application of CAD software.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These assessable statements specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| --- | --- |
| 1. Use and maintain drawing equipment and materials | * 1. ***Drawing equipment*** are obtained according to task requirements   2. ***Drawing materials*** are obtained according to task requirements   3. Drawing equipment are used and maintained according to manufacturer instructions   4. Drawing materials are used according to task requirements   5. Waste materials are disposed in accordance with workplace procedures and ***environmental legislations***   6. ***Personal Protective Equipment*** is used according to occupational safety and health regulations |
| 1. Produce plain geometry drawings | * 1. Lettering and line work is done according to drawing rules   2. Sketches of ***geometric forms*** are interpreted according to standard conventions   3. Different types of angles are constructed according to principles of trigonometry   4. Different types of geometric forms are constructed according to standard drawing conventions   5. Constructed geometric forms are dimensioned according to drawing requirements |
| 1. Produce solid geometry drawings | * 1. ***Sketches of patterns*** are interpreted according to work requirements   2. Interpenetrating surface of solids and truncated solids are developed according to work requirements   3. ***Interpenetrations of solids*** of equal and unequal is done according to work requirements |
| 1. Produce pictorial and orthographic drawings of components | * 1. Different symbols and abbreviations are identified and their meaning interpreted according to standard drawing conventions   2. Isometric sketches and drawings of components are interpreted and produced in accordance with the standard conventions of isometric drawings   3. First and third angle orthographic sketches and drawings of components are produced in accordance with the standard conventions of orthographic drawings   4. Freehand sketching of different types of geometric forms, tools, equipment, diagrams and components is conducted |
| 1. Produce assembly drawings | * 1. Orthographic views are exploded according to standard conventions of orthographic drawings.   2. Pictorial views are exploded according to standard conventions of orthographic drawings.   3. Part lists are identified according to drawing specifications   4. Sectional views are produced according to standard conventions of drawing.   5. Produced drawing is hatched according to standard conventions of drawings. |
| 1. Apply CAD in technical drawing | * 1. ***CAD software*** are identified according to work requirements   2. 2-D models are produced according to work requirements   3. 3D models are produced according to work requirements   4. Produced models are annotated according to work requirements |

**RANGE**

| **Variable** | **Range** |
| --- | --- |
| 1. Drawing equipment may include but is not limited to: | * Drawing boards * T-square * Set squares * Drawing set * French curves * Computers |
| 1. Drawing materials may include but is not limited to: | * Drawing papers * Pencils * Erasers * Masking tapes * Paper clips |
| 1. CAD software may include but is not limited to: | * AutoCAD * Inventor * Solid Works * Archi CAD * Electronic work bench * Circuit maker * Proteus |
| 1. Sketches of patterns may include but is not limited to: | * Cylinders * Prisms * Pyramids |
| 1. Interpenetrations of solids may include but is not limited to: | * Cylinder to cylinder * Cylinder to prism * Prism to prism |
| 1. Environmental legislations may include but is not limited to: | * EMCA 1999 * NEMA Regulations |
| 1. Personal Protective Equipment may include but is not limited to: | * Dust coats * Closed leather shoes * Goggles for CAD |
| 1. Geometric forms may include but is not limited to: | * Circles * Triangles * Rectangles * Parallelogram * Polygons * Pyramids * Conic sections * Prisms * Loci |
| 1. Standard drawing conventions may include but is not limited to: | * Anatomy of engineering drawing (title block, coordinate grid system, revision block, notes and legends) * Drawing scale (paper size and drawing symbols) * International drawing standards |

**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 relations
* Computer

**Required knowledge**

The individual needs to demonstrate knowledge of:

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

**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 in production of drawings |
| 1. Resource Implications | Resources the same as that of workplace are advised to be applied.   * 1. Drawing room   2. Drawing equipment and materials   3. Computers   4. CAD software   5. PPE   6. Internet |
| 1. Methods of Assessment | Competency may be assessed through:   * 1. Practical tests |
| 1. Context of Assessment | Competency may be assessed individually in the actual workplace or a simulated work place setting or in industrial attachment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY NGINEERING MATHEMATICS

**UNIT CODE:** ENG/OS/MC/CC/02/5/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** |
| 1. Hyperbolic functions include but not limited to: | * + Sinh x   + Cosh x   + Cosec x   + Coth x   + Tanh x   + Sech x |
| 1. Figures include but not limited to: | * + Triangles   + Squares   + Rectangles   + Circles   + Spheres   + Cylinders   + Cubes   + Polygons   + Cuboids   + Pyramids |
| 1. 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:   * 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 individually in the actual workplace or through accredited institution or 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 AND ELECTRONICS PRINCIPLES

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

**UNIT DESCRIPTION**

This unit describes the competencies required by a mechatronic technician in order to apply a wide range of electrical and electronics principles skills in their work. It involves use of the concept of basic electrical quantities, use of the concepts of D.C and A.C circuits in electrical installation, use of basic electrical machine, carrying out power rectification in electrical systems, use earthing in electrical installations and applying lightning protection measures

**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 according to specified procedures   2. ***Quantitie***s of Charge, force, work and power are identified according to specified procedures   3. Calculations involving various electrical quantities are performed according to specified procedures |
| * + 1. Use the concepts of D.C and A.C circuits in electrical installations | * 1. Perform calculations involving Ohm’s law that is Current, Resistance and voltage according to specified procedures   2. Calculations involving parallel and series circuits are performed according to specified procedures   3. Calculations involving DC and AC Network theorems are performed. E.g. Kirchhoff’s laws, Superposition, Thevinin’s, Norton’s according to specified procedures |
| * + 1. Use of basic electrical machine | * 1. Types of various electrical machines are identified according to work specifications   2. Calculations involving single phase and three phase AC and DC Motors are performed in accordance to electrical guidelines   3. Calculations involving single and three phase AC and DC transformers are performed according to electrical guidelines   4. Calculations involving single and three phase generators are performed in accordance to electrical guidelines |
| * + 1. Carry out power rectification in electrical systems | * 1. Power rectification is performed using various ***power rectification methods*** according to prescribed rectification methods   2. Power smoothing is done according to prescribed ***power smoothing methods***   3. Power regulation is performed according to selected power regulation methods   4. Power supply protection is carried out according to prescribed ***power supply protection methods*** |
| * + 1. Use of earthing in electrical installations | * 1. Earthing types are identified in accordance to Electric Power Act, 1997 standards   2. Earthing points on electrical installation are identified according to work requirements   3. Calculation involved in determining the earthing type is performed according to prescribed work   4. Test on an earthing system is performed in line with the Electric Power Act, 1997 standards |
| * + 1. Apply lightning protection measures | * 1. Types of lightening strokes are identified according to prescribed procedures   2. Components of lightening protection system are identified according to Electric Power Act, 1997 standards   3. Test to be carried out in lightening protection system are established in accordance Electric Power Act, 1997 standards   4. Application of lightening protection system is determined in accordance to system 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. 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 |
| 1. Power rectification methods may include but not limited to: | * + Half wave   + Full wave   + Full wave bridge |
| 1. Power smoothing methods may include but not limited to: | * + Reservoir   + Capacitor filter   + R.C filter   + Pie filter |
| 1. Power supply protection methods may include but not limited to: | * + Circuits breakers   + Fuses   + Switches |

**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:

* Use of basic Electrical instruments
* 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
* Electrical formulas
* Various unit conversions of Electrical quantities
* Various laws in Electrical engineering
* Electrical formulas
* Power triangle
* SI units of various electrical parameters
* Earthing testing
* Lightening arrestor testing
* 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. Electro-mechanical measuring equipment   3. Materials relevant to the proposed activity or tasks |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   * 1. Practical test   2. Oral Questioning   3. Written tests |
| 1. Context of Assessment | Competency may be assessed individually in the actual workplace or through accredited institution or 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 AND PRACTICES

**UNIT CODE:** ENG/OS/MC/CR/04/5/A

**UNIT DESCRIPTION**

This unit describes the competencies required by a Mechatronic Craftsperson in order to apply a wide range of workshop technology skills in their work. It involves use of technical drawing to plan work operations, measuring and marking out dimensions on work pieces, using hand tools to cut and file parts, threading using taps and dies, producing components using a lathe and milling machine, assembling metal parts and sub-assemblies, performing housekeeping, inspecting finished work for accuracy and quality and maintaining 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 italicized terms are elaborated in the Range*** |
| --- | --- |
| 1. Use technical drawing to plan work operations | * 1. Technical drawings are produced ***as*** per ***drawing standards***   2. Technical drawings and geometric symbols are read and interpreted as per drawing standards.   3. ***Operation plan*** is produced as per the technical drawings. |
| 1. Measure and mark out dimensions on work pieces | * 1. Measuring tools suitable for the work are selected according to task description   2. Measuring tools are inspected and calibrated as per requirements   3. Dimensions are marked on the work piece as per the working drawing. |
| 1. Use hand tools to cut and file parts | * 1. ***Hand tools*** are selected based on operation plan   2. Work piece is cut to specification based on job requirement   3. Work piece is filed to specification based on job requirement   4. Part are produced to ***specifications*** based on work requirement |
| 1. Use drills to make holes | * 1. Hole centers are marked and center-punched as per operation plan.   2. Drill bits are selected and mounted according to work requirements   3. Work piece is mounted and clamped according to workshop regulations   4. Hole is drilledto specification according to work requirements   5. Holes inspected to specification according to work requirements |
| 1. Thread using taps and dies | * 1. Taps and dies selected based on operation plan.   2. Taps and dies are set up on the work piece according to work specifications   3. Work piece is clamped according to work requirements   4. ***Threads*** are cut according to work specifications |
| 1. Produce components using a lathe and milling machine | * 1. Work piece is faced according to work specifications   2. Work pieces are turned according to work requirements   3. Work piece is threaded according to work requirements   4. Work piece is drilled according to work requirements   5. Work piece is bored according to work requirements   6. Work piece is milled according to specified milling operation |
| 1. Assemble metal parts and sub-assemblies | * 1. ***Joining and assembly method*** is selected according to work requirements   2. Parts joined, fitted and assembled according to the specified assembly and joinery methods   3. Final assembly is inspected as per specification |
| 1. Perform surface finish | * 1. ***Surface finishing method*** is selected according to work requirements   2. Surface finishing materials are selected according to work requirements   3. Work piece is surface finished according to work requirements |
| 1. Perform housekeeping | * 1. Waste is segregated and disposed as per disposal guidelines.   2. Housekeeping is carried out as per workplace requirement   3. Tools and equipment are stored in accordance to manufacturer requirement |
| 1. Inspect finished work for accuracy and quality | * 1. Inspection tools and methods are selected as per operation plan   2. Finished work is inspected as per specification   3. Adjustments are made based on inspections results |
| 1. Maintenance of tools and equipment | * 1. Machines and tools are inspected in accordance to manufacturer specifications   2. Machines and tools are lubricated according to manufacturer manual   3. Tools are ground to manufacturer specification   4. Faults on machines and tools are identified and reported according to maintenance manual |

**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. Measuring tools may include but not limited to: | * + Steel rule   + Vernier calliper   + Micrometre screw gauge   + Vernier height gauge   + Combination set   + Bevels |
| 1. Drawing Standards may include but not limited to: | * + ISO   + BS   + ANSI |
| 1. Operation Plan may include but not limited to: | * + Sequence of operations   + Measuring tools   + Hand tools   + Cutting tools   + Inspection tools |
| 1. Marking out tools may include but not limited to: | * + Scribers   + Dividers   + Dot punch   + Centre punch   + Engineers square   + Straight edge   + Surface plate |
| 1. Work holding devices may include but not limited to: | * + Bench vice   + V-Block   + Angle plate   + G-clamp   + Jigs and fixtures   + Hand vice |
| 1. Hand tools may include but not limited to: | * + Files   + Saws   + Hammers   + Chisels   + Taps and dies |
| 1. Threads may include but not limited to: | * + Internal and external threads   + V-profile threads |
| 1. Surface finishing methods may include but not limited to: | * + Filing/deburring   + Tumbling   + Plating   + Painting |
| 1. Joining and assembly method may include but not limited to: | * + Riveting   + Fastening   + Soldering   + Brazing   + Welding |
| 1. Specifications may include but not limited to: | * + Dimensions   + Tolerances   + Geometry   + Surface finish   + Functionality |

**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:

* Technical drawing
* Using measuring and inspection tools
* Using hand tools
* Using portable and bench drilling machines
* Soldering and brazing
* Riveting and fastening
* Use of the lathe machine
* Use of milling machine
* Using grinding machine

**Required Knowledge**

The individual needs to demonstrate knowledge and understanding of:

* Occupational Health and Safety Act of Kenya laws 2007 with focus on personal safety, machine safety and workplace
* National Environment Management Authority Act, Kenya 2004
* Equipment manuals
* Basic technical drawing complyingto ISO, ANSI & BS standards
* ISO 1101 Geometrical tolerance and where to use the norm
* Work Planning and documentation
* Measuring tools
* Bench work
* Portable and bench drilling machines
* Lathe machine
* Grinding machine
* Inspection and quality control
* Preventive maintenance of machine tools
* Metal cutting technology
* Materials and metallurgy
* WIBA act (2007)
* Report writing

**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 learner:   * 1. Observed rules and procedures in the workshop   2. Interpreted technical drawing   3. Produced operation plan   4. Produced holes on a work piece   5. Threaded using taps and dies   6. Assembled metal parts   7. Surface finished work piece   8. Maintained tools and equipment   9. Did housekeeping before, during and after operations |
| 1. Resource Implications | * 1. Hand tools   2. Inspection tools and equipment   3. Hand drilling machine   4. Bench Drilling machine   5. Lathe machine   6. Grinding machine   7. Milling machines   8. Work benches |
| 1. Methods of Assessment | Competency may be assessed through:   * 1. Practical tests   2. Oral questioning   3. Inspection of written operation procedures   4. Written test |
| 1. Context of Assessment | Competency may be assessed individually in the actual workplace or through accredited institution or 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

## INSTALL MECHATRONIC SYSTEMS

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

**UNIT DESCRIPTION**

This unit covers the competencies required to install mechatronic systems. It involves competencies to install system wiring, install electrical devices install piping system, install mechanical system, install electronics equipment system and install sensing devices in system.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.***(Bold and italicized terms are elaborated in the Range)*** |
| --- | --- |
| 1. Install system wiring | * 1. Circuit diagram is designed according to engineering and user specifications   2. ***Wiring Materials*** are identified according to the circuit diagram specifications   3. ***Tools and equipment*** are identified according to the job requirement   4. Wiring materials are laid out according to the circuit diagram   5. ***Mechanical units of wiring*** are installed according to prescribed method of installation   6. Electrical system is installed according to circuit diagrams design and user requirement   7. Electrical wiring is tested and commissioned for desired operation according design specifications |
| 1. Install electrical devices | * 1. Installation manuals are obtained for system installation according to SOPs   2. Work permit is obtained for commencement of system installation according to organization policy   3. Individual ***electrical*** ***equipment parts*** in the mechatronic system are tested according the prescribed functionality   4. Electrical equipment is installed in the Mechatronic system according to the required method of equipment induction   5. Documentation of test results is done according to system requirement |
| 1. Install piping system | * 1. Piping diagram is designed according to user specifications   2. Piping materials are inspected according to specifications   3. ***Piping tools and equipment*** are identified according to the system requirement   4. Piping system is installed for mechatronic system according to user specifications   5. Piping system is inspected and tested according to system functionality |
| 1. Install mechanical system | * 1. Floor level is checked according to the system specifications   2. Working diagram is developed according user specifications   3. Foundations of the mechanical equipment structure is laid according to working diagram   4. Mechanical equipment and structure is identified and inducted according to system specification   5. Mechanical machines/equipment are installed according to the user manual   6. Mechanical systems are inspected, tested and commissioned according to the desired functionality |
| 1. Install electronics equipment system | 1. Electronic equipment in mechatronic is installed according to prescribed method of operation 2. A.C and D.C drives are installed in mechatronic systems according to installation manual 3. Digital displays and indicators are identified and installed according to prescribed mode of installation 4. Monitoring and control systems are installed according to installation manuals 5. Electronic equipment is tested according to system functionality |
| 1. Install sensing devices in system | * 1. Installation manuals are obtained for system installation   2. Tools and equipment are identified according to job specifications   3. Sensors are identified according to system functionality   4. Sensors are installed in Mechatronic system according to recommended mode of installation   5. Calibration equipment in the mechatronic system are installed according to the prescribed mode of installation   6. Sensors are tested according to system functionality |

**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. Wiring Materials may include but is not limited to: | * Cables * Sockets * Circuit breakers * Distribution boards * Consumer units * TPN * Cut outs * Switches * Capacitor Banks * Transformers * Batteries |
| 1. Tools and equipment may include but is not limited to: | * Hand tools * Power tools * Machines |
| 1. Mechanical units of wiring may include but is not limited to: | * Junction boxes * Conduits * Meter board |
| 1. Electrical equipment parts may include but is not limited to: | * Sensors * Actuators |
| 1. Piping tools and equipment may include but is not limited to: | * Pipe wrenches * Adjustable spanners * Masonry fit |

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required Skills**

***The individual needs to demonstrate skills in:***

* Design of mechatronic systems
* Communication skills
* Problem solving
* Creativity and innovation
* Data collection and analysis
* Use of tools and equipment
* Technical presentation
* Technical drawing
* Pipe work
* Installation and fabrication

**REQUIRED KNOWLEDGE**

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

* Electrical circuit design
* Mechanical structural design
* Computer Aided Design
* Mechatronic programming
* Technical report writing
* Data analysis and interpretation
* Interpretation of technical drawings
* Documentation
* Types of tools and equipment
* Properties of materials
* Electrical and mechanical machine drives
* Pipe work
* Testing and inspection
* Sensors and transducers

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency. | Assessment requires evidence that the learner:   * 1. Installed system wiring   2. Installed electrical devices   3. Installed piping system   4. Installed mechanical system   5. Installed electronics equipment system   6. Installed sensing devices in system |
| 1. Resource Implications. | * 1. Computers   2. Software   3. Projectors   4. Markers   5. Whiteboards   6. Tools and equipment   7. Whiteboard markers |
| 1. Methods of Assessment. | ***Competency may be assessed through:***   * 1. Practical   2. O   3. Case studies   4. Written examinations   5. Oral presentation |
| 1. Context of Assessment. | 4.1 Competency may be assessed individually in an actual workplace or in work-simulated conditions within accredited institutions. |
| 1. Guidance information for assessment. | * 1. Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## MAINTAIN ELECTRO-MECHANICAL SYSTEMS

**UNIT CODE:** ENG/OS/MC/CR/02/5/A

**UNIT DESCRIPTION**

This unit describes the competencies required by a technician in order to maintain electro-mechanical systems. It involves observing occupational health and safety, troubleshooting electro-mechanical faults, servicing and/or repairing electrical and mechanical system faults, testing electro-mechanical systems and scheduling maintenance of electro-mechanical systems.

**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. Troubleshoot electro-mechanical faults | * 1. Proper authorization is obtained according to statutory policy   2. Circuit diagram is interpreted according to system manual   3. Tools and equipment are identified according to machine manual requirement   4. Electro-mechanical fault is identified according to recommended steps/procedures in the service manual |
| 1. Service and/or repair electrical system | * 1. Tools and equipment are operated correctly according to manufacturer specifications.   2. Electrical system is serviced according manufacturer specifications.   3. ***Faulty devices*** are detached from the system according to necessary safety procedures   4. Faulty devices are repaired/replaced according to the service manual and specifications   5. Electrical faults and/or repairs are documented according to SOPs |
| 1. Service and/or repair mechanical system faults | * 1. Tools and equipment are operated correctly according to manufacturer specifications   2. Mechanical system is serviced according manufacturer specifications.   3. Faulty devices are detached from the system according to necessary safety procedures   4. Faulty devices are repaired/replaced according to the service manual and specifications   5. Mechanical faults and/or repairs are documented according to SOPs |
| 1. Test electro-mechanical system | * 1. Termination/insulation of electrical wiring contacts are verified according to IEEE standards.   2. Validation of mechanical linkages and joints are done according to service manual   3. Electro-mechanical system is tested to confirm its proper operation according to manufacturer specifications   4. Test results are documented according to SOPs |
| 1. Schedule maintenance of electro-mechanical system | * 1. Normal service schedule is determined according to manufacturer specifications   2. New service schedule is developed after breakdown repairs according to operational specifications   3. Maintenance schedule is documented according to SOPs |

**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. Personal protective equipment may include but is not limited to: | * Goggles * Ear muff * Safety mask * Helmets/head gear * Safety boots * Gloves * Overall/dust coat |
| 1. Tools and equipment may include but is not limited to: | * Hand tools * Power tools * Machines |
| 1. Faulty devices may include but is not limited to: | * Sensors * Motor drives * Gears * Pulleys * Bearings * Drive shafts * Instruments * Electrical wiring * Mechanical linkages * Belts and chains |

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required Skills**

***The individual needs to demonstrate skills in:***

* Communication skills
* Problem solving
* Data collection and analysis
* Use of tools and equipment
* Technical drawing
* Service and repair of system components
* Fault diagnosis
* Interpretation of circuit
* Use of test and measuring instruments
* Planning

**Required Knowledge**

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

* Mechatronic programming
* Technical report writing
* PPE
* Interpretation of technical drawings
* Documentation
* Types of tools and equipment
* Electrical and mechanical machine drives
* Machine operation
* Types of maintenance
* Circuit interpretation
* Scheduling/planning for maintenance
* Basics on electrical circuits
* Basics on mechanical installation

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency. | * 1. Place and observe safety signs   2. Identified electro-mechanical faults   3. Serviced and/or repaired electrical system faults   4. Serviced and/or repaired mechanical system faults   5. Tested electro-mechanical system after service/repair   6. Scheduled maintenance of electro-mechanical systems |
| 1. Resource Implications. | * 1. Computers   2. Software   3. Whiteboards   4. Tools and equipment   5. Whiteboard markers   6. Manuals |
| 1. Methods of Assessment. | ***Competency may be assessed through:***   * 1. Practical test   2. Observation   3. Questionnaire   4. Case studies   5. Written test |
| 1. Context of Assessment. | * 1. Competency may be assessed individually in an actual workplace or in work-simulated conditions within accredited institutions or during industrial attachment |
| 1. Guidance information for assessment. | * 1. Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## MAINTAIN MECHATRONIC SYSTEMS INSTRUMENTATION AND CONTROL

**UNIT CODE:** ENG/OS/MC/CR/03/5/A

**UNIT DESCRIPTION**

This unit covers the competencies required to maintain Mechatronic systems Instrumentation and control. It involves to document the control system design and specifications, install mechatronic instrumentation and control system, analyze instrumentation and control data and service and/or repair system faults

**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. Document the control system design and specifications | * 1. ***Technical report*** is developed according to the control system design and specifications.   2. Operation and maintenance manual is developed according to control system design and specifications   3. The control system design is patented according to Industrial Property Act,2001 |
| 1. Install mechatronic instrumentation and control system | * 1. Existing mechatronic system manuals are obtained from the user and studied for the system performance   2. Safety and precaution measures are observed according OSHA   3. Tools and equipment are selected according system functionality   4. Interfacing of the controller and the mechatronic system is done according to prescribed system performance   5. System performance is studied, monitored, tested an evaluated according to prescribed system specification   6. Calibration of the system is done according to the system functionality   7. Documentation is done for future reference and use   8. System is commissioned for use according to the prescribed functionality |
| 1. Analyse instrumentation and control data | * 1. ***Data*** to be analysed is decided according to the inputs and the outputs of the controller and the mechatronic system performance   2. ***Methods of data collection*** is selected according system performance   3. Data from the system is collected according to system performance   4. Documentation of the collected data is done according to the system performance   5. Data is interpreted and analysed according to the system performance   6. Interpreted and analysed data is documented for future use |
| 1. Service and/or repair system faults | * 1. Installation manuals are obtained from the user and analysed for functionality of the system   2. Safety and precaution measures are observed according OSHA.   3. Tools and equipment are selected according to installation and service manuals   4. System testing is done for comparison with the manufacturer’s specifications and system functionality.   5. Fault diagnosis is done according to service manuals instructions   6. Faulty units removed and replaced with new ones and moving parts lubricated according to the system performance   7. System is tested against the required specifications   8. Scheduling of the next service is done according to SOPs   9. Documentation is done for future use and reference |

**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. Tools and equipment may include but is not limited to: | * Hand tools * Power tools * Machines |
| 1. PPEs may include but is not limited to: | * Overall/dust coats * Helmets * Nose masks * Ear muffs * Safety boots |
| 1. Controller components may include but is not limited to: | * PLC * Contactors * Relays * Displays * Keyboards and keypads * Control Buttons/switches |
| 1. Data may include but is not limited to: | * Power * Temperature data * Pressure data * Current and voltage * Frequency * Heat |
| 1. Methods of data collection may include but is not limited to: | * Observation * Experiments * Questionnaires |

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required Skills**

***The individual needs to demonstrate skills in:***

* Communication skills
* Problem solving
* Creativity and innovation
* Data collection and analysis
* Use of tools and equipment
* Technical presentation
* Technical drawing
* Installation and fabrication
* Interpretation of installation manuals
* Integration of robotics and automated processes
* Service and maintenance
* Control and instrumentation interfacing

**Required Knowledge**

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

* Electrical circuit design
* Mechanical structural design
* Computer Aided Design
* Mechatronic programming
* Technical report writing
* Data analysis and interpretation
* Interpretation of technical drawings
* Documentation
* Types of tools and equipment
* Electrical and mechanical machine drives
* Testing and inspection
* Sensors and transducers
* Robotics and automated processes
* Hydraulics and pneumatics systems
* Service and maintenance of mechatronics processes
* Control and instrumentation
* Integration of control to mechatronic system

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency. | Assessment requires evidence that the learner:   * 1. Observed occupational health and safety   2. Designed a control system   3. Documented the control system design and specifications   4. Installed mechatronic instrumentation and control system   5. Analysed instrumentation and control data   6. Serviced and/or repaired system faults |
| 1. Resource Implications. | * 1. Computers   2. Software   3. Projectors   4. Markers   5. Whiteboards   6. Tools and equipment   7. Whiteboard markers |
| 1. Methods of Assessment. | ***Competency may be assessed through:***   * 1. Practical tests   2. Observation   3. Questionnaire   4. Case studies   5. Written tests   6. Oral presentation |
| 1. Context of Assessment. | 4.1 Competency may be assessed individually in an actual workplace or in work-simulated conditions within accredited institutions or during industrial attachment |
| 1. Guidance information for assessment. | * 1. Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## OPERATE ROBOTIC AND AUTOMATED SYSTEMS

**UNIT CODE:** ENG/OS/MC/CR/04/5/A

**UNIT DESCRIPTION**

This unit covers the competencies required to operate robotic and automated systems. It involves competencies to; observe occupational health and safety, interpret installation manuals, install robotic and automated systems, integrate robotic and automated system to existing system, test and commission mechatronic system and Service and maintain robotic and automated system faults

**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. Interpret installation manuals | ***1.1 Installation manuals*** are obtained from the user according to equipment specifications  ***1.2*** Manuals are studied and analysed according to the components functionality  1.3 Manuals are stored for future use and references |
| * 1. Install robotic and automated systems | ***2.1 Robotic and automated systems*** components are identified according to the installation manuals and user specifications  ***2.2*** Components are inspected according to the prescribed systems specifications  2.3 ***Tools and equipment*** are selected according to the installation manuals  2.4 Robotic and automated system components are assembled together according to installation manuals  2.5 Robotic and automated systems are connected to the required power supply according the component power specifications and manuals  2.6 Control systems are interfaced to the system according to user specifications and installation manuals  2.7 System programming is done according to functionality of the system  2.8 Program is uploaded to the robotic and automated system according to prescribed functionality  2.9 Inspection of the assembled system is done as per installation manuals and system functionality  2.10 Assembled components are tested according to the system specifications  2.11 Documentation is done according to the obtained end results  2.12 Program is debugged and tested according to the system functionality  2.14 Robotic and automated system is operationalized according to the user specification |
| * 1. Integrate robotic and automated system to existing system | * 1. Manuals for the existing system are obtained from the user   2. Safety and precaution measures are observed according OSHA   3. Existing system is studied and analysed according to its prescribed functionality   4. Appropriate tools and equipment are selected according to the installation manuals   5. Existing and the new system are tested for compatibility according to the user specification   6. New system and the existing system are interfaced together according to the user specification and system functionality   7. Interfaced system is calibrated according to the system functionality   8. Documentation of the results is done for future reference |
| * 1. Test and Commission mechatronic system | * 1. Interfaced system is tested for functionality according to system specifications   2. Monitoring, evaluation and assessment of the system performance is done according to the system functionality   3. System commissioning is done according to the prescribed user specifications |
| * 1. Service and maintain robotic and automated system faults | * 1. Installation manuals are obtained from the user and analysed for functionality of the system   2. Safety and precaution measures are observed according OSHA.   3. Tools and equipment are obtained according the manual specifications   4. System testing is done for comparison with the manufacturer’s specifications and system functionality.   5. Fault diagnosis is done according to service manuals instructions   6. Faulty units removed and replaced with new ones considering their compatibility with the system   7. System is tested against the required specifications   8. Documentation is done for future use according to user specifications |

**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. Tools and equipment may include but is not limited to: | * Hand tools * Power tools * Machines |
| 1. Robotics and automated systems may include but is not limited to: | * Robotic arms * Chassis * End effectors * Actuators * Sensors * CPU * Programming |
| 1. Installation manuals may include but is not limited to: | * Electrical and electronic components manuals * Mechanical components manuals * Pneumatics manuals * Hydraulic manuals * Programming manuals * Servicing and troubleshooting manuals |

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required Skills**

***The individual needs to demonstrate skills in:***

* Communication skills
* Problem solving
* Creativity and innovation
* Data collection and analysis
* Use of tools and equipment
* Technical presentation
* Technical drawing
* Installation and fabrication
* Interpretation of installation manuals
* Integration of robotics and automated processes
* Service and maintenance

**Required Knowledge**

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

* Electrical circuit design
* Mechanical structural design
* Computer Aided Design
* Mechatronic programming
* Technical report writing
* Data analysis and interpretation
* Interpretation of technical drawings
* Documentation
* Types of tools and equipment
* Properties of materials
* Electrical and mechanical machine drives
* Testing and inspection
* Sensors and transducers
* Robotics and automated processes
* Hydraulics and pneumatics systems
* Service and maintenance of mechatronics processes
* Control and instrumentation
* Interfacing of mechatronics components
* Integration of mechatronics components

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency. | Assessment requires evidence that the learner:  1.1 Observed occupational health and safety  1.2 Interpreted installation manuals  1.3 Installed robotic and automated systems  1.4 Integrated robotic and automated system to existing system  1.5 Tested and Commissioned mechatronic system  1.6 Service and maintain robotic and automated system faults |
| 1. Resource Implications. | * 1. Computers   2. Software   3. Projectors   4. Markers   5. Whiteboards   6. Tools and equipment   7. Whiteboard markers |
| 1. Methods of Assessment. | ***Competency may be assessed through:***   * 1. Practical test   2. Observation   3. Questionnaire   4. Case studies   5. Written tests   6. Oral presentation |
| 1. Context of Assessment. | 4.1 Competency may be assessed individually in an actual workplace or in work-simulated conditions within accredited institutions or during industrial attachment. |
| 1. Guidance information for assessment. | * 1. Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## OPERATE PNEUMATIC AND HYDRAULIC SYSTEMS

**UNIT CODE:** ENG/OS/MC/CR/05/5/A

**UNIT DESCRIPTION**

This unit describes the competencies required by a technician in order to operate pneumatic and hydraulic systems. It involves observing occupational health and safety, installing pneumatic and hydraulic systems, testing and inspecting pneumatic and hydraulic systems, integrating and verifying pneumatic and hydraulic system parameters, servicing and maintaining pneumatic and hydraulic systems and redesigning existing systems with hydraulic/ pneumatic systems.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.***(Bold and italicized terms are elaborated in the Range)*** |
| --- | --- |
| 1. Install pneumatic and hydraulic systems | * 1. Site visit authorization is obtained according to organization policy   2. Site specifications are obtained using the right tools and equipment   3. Site specifications are documented according to SOPs.   4. Installation manuals are interpreted according to SOPs   5. Pneumatic and hydraulic system components are identified according installation manual   6. System components layout is done according to installation manual   7. Tools and equipment are selected and operated correctly according to manufacturer’s specifications   8. Pneumatic and hydraulic system is installed according to installation manual |
| 1. Test and inspect pneumatic and hydraulic systems | * 1. ***Peripheral devices*** are verified if they are properly connected according system manual   2. Peripheral devices functionality is verified according to system manual   3. Fluid ***validity*** is verified according prescribed system requirements   4. ***Fluid*** leakages are checked according to prescribed fluid leakage checking methods   5. ***Testing equipment*** are selected and operated correctly according to manufacturer’s specifications   6. Fluid flow is tested according to design specifications   7. Instruments and controllers are tested according to system requirements |
| 1. Integrate and verify pneumatic and hydraulic system parameters | * 1. Correct installation of peripheral devices is verified according to system manual   2. Pneumatic/hydraulic system is integrated to system according to system specifications   3. System is run to verify whether it works correctly according design specifications |
| 1. Service and maintain pneumatic and hydraulic systems | * 1. Tools and equipment are operated correctly according to manufacturer’s specifications   2. System fault diagnosis is done according to manufacturer’s specifications   3. Faulty devices are detached from the system according to necessary safety procedures   4. Faulty devices are repaired/replaced according to the service manual and specifications   5. System faults and/or repairs are documented according to SOPs |
| 1. Redesign existing systems with hydraulic/ pneumatic systems | * 1. Need for pneumatic/hydraulic inclusion in a system is determined according to system operation   2. Design of layout of pneumatic/hydraulic system is done according requirements   3. Designed system is interfaced and tested to system according to design layout   4. Designed system is documented according to SOPs |

**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. Personal protective equipment may include but is not limited to: | * Goggles * Ear muff * Safety mask * Helmets/head gear * Safety boots * Gloves * Overall/dust coat |
| 1. Tools and equipment may include but is not limited to: | * Hand tools * Power tools * Machines |
| 1. Peripheral devices may include but is not limited to: | * Pipes/tubes/hoses * Gauges * Valves * Instruments * Sensors * Pumps * Reservoirs * Compressors * Regulators * Filters * Seals * Power units |
| 1. Fluid may include but is not limited to: | * Oils * Air * Water |
| 1. Validity may include but is not limited to: | * Pressure * Temperature * Contamination/impurities * Viscosity * Density * Fluid life cycle |
| 1. Testing equipment may include but is not limited to: | * Leakage tester/detector * Instruments /gauges |

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required Skills**

***The individual needs to demonstrate skills in:***

* Testing of hydraulic and pneumatic systems
* Operating of hydraulic and pneumatic systems
* Equipment inspection and testing
* Communication skills
* Problem solving
* Data collection and analysis
* Service and repair of system components
* Fault diagnosis

**Required Knowledge**

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

* Networking
* Documentation
* Scheduling/planning for maintenance
* Logic control
* Scientific methods
* Fluid dynamics
* Thermodynamics
* Machine design
* Interpretation of hydraulics and pneumatics drawings/manuals
* Standard units used in fluids
* Description of fluid parameters
* Operation of hydraulic and pneumatic systems
* Fluid control
* Basic equations of fluid behaviour
* Service and repair of hydraulics and pneumatics
* Tools and testing equipment
* Pneumatic and hydraulic system performance

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency. | Assessment requires evidence that the learner:   * 1. Observed occupational health and safety   2. Installed pneumatic and hydraulic systems   3. Tested and inspected pneumatic and hydraulic systems   4. Integrated and verified pneumatic and hydraulic system parameters   5. Serviced and maintained pneumatic and hydraulic systems   6. Redesigned existing systems with hydraulic/ pneumatic systems |
| 1. Resource Implications. | * 1. Computers   2. Software   3. Whiteboards   4. Whiteboard markers   5. Manuals   6. Controllers (PLCs etc.)   7. Pneumatic and hydraulic components |
| 1. Methods of Assessment. | ***Competency may be assessed through:***   * 1. Practical test   2. Observation   3. Oral questioning   4. Case studies   5. Written tests   6. Oral presentation |
| 1. Context of Assessment. | * 1. Competency may be assessed individually in an actual workplace or in work-simulated conditions within accredited institutions or during industrial attachment. |
| 1. Guidance information for assessment. | * 1. Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## OPERATE PROGRAMMABLE LOGIC CONTROL (PLC) SYSTEMS

**UNIT CODE:** ENG/OS/MC/CR/06/5/A

**UNIT DESCRIPTION**

This unit describes the competencies required by a technician in order to operate PLC systems. It involves installing of PLC systems, applying tug-out on PLC systems, installing application software, testing and configuring of input/output modules, sensors and PLC units, diagnosing faults on PLC systems and maintaining PLC systems.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.***(Bold and italicized terms are elaborated in the Range)*** |
| --- | --- |
| 1. Install PLC system | 1. PLC and electrical safety rules are observed according to OSHA, 2007 2. Appropriate ***tools and equipment*** are selected for installation and testing according to system requirements 3. PLC model specifications is determined according to manufacturer specifications 4. Grounding of PLC system is performed according to installation standards 5. ***Peripheral devices*** used with unit are identified, assembled and networked according to circuit diagram 6. PLC system is installed according to system manual |
| 1. Apply tug-out on PLC system | * 1. PLC wires and cables are identified according to schematic/wiring diagrams   2. Manual switches are set according to desired operations   3. PLC is tugged out from the system according to recommended tug-out methods |
| 1. Install application software | * 1. Network data communication is performed according to recommended procedure   2. PLC system software is formatted according to recommended procedure   3. PLC software installation is performed according to recommended procedure   4. System software is run according to installation manual |
| 1. Test and configure I/O modules, sensors, and PLC unit | * 1. PLC program is configured according to desired operation   2. Input and output modules are verified according manufacturer specifications   3. Central processing unit of the PLC is verified for normal operation according to system manual   4. Sensors used on PLC are tested according to set standards |
| 1. Diagnose faults on PLC system | * 1. Input/output modules are verified for optimum performance according system specifications   2. Malfunctions due to ladder logic program are determined according to system operation   3. Malfunctions due to peripheral devices are determined according to system operation |
| 1. Maintain PLC system | * 1. A dust free environment is maintained around PLC system according to SOPs   2. PLC unit and peripheral devices are kept clean according to SOPs   3. Measures to keep temperature within limits are taken according set standards   4. Faulty equipment and devices are removed and replaced according to system manual |

**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. Tools and equipment may include but is not limited to: | * Hand tools * Electrical testing tools and equipment |
| 1. Peripheral devices may include but is not limited to: | * Input/output chassis * Input module * Output module * Sensors * Actuators * Wiring * Networking equipment |

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required Skills**

***The individual needs to demonstrate skills in:***

* Testing of PLC systems
* Operating of PLC systems
* Communication skills
* Problem solving
* Data collection and analysis
* Service and repair of system components
* Fault diagnosis
* PLC programming

**Required Knowledge**

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

* Networking of systems
* Documentation
* Scheduling/planning for maintenance
* Logic control
* Scientific methods
* Interpretation of PLC circuit diagrams and manuals
* Operation of PLC systems
* Control systems
* Service and repair of PLC units
* Tools and testing equipment
* PLC system performance

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency. | Assessment requires evidence that the learner:   * 1. Observed occupational health and safety   2. Install PLC system   3. Apply tug-out on PLC system   4. Install application software   5. Test and configure I/O modules, sensors, and PLC unit   6. Diagnose faults on PLC system   7. Maintain PLC system |
| 1. Resource Implications. | * 1. Computers   2. Software   3. Whiteboards   4. Whiteboard markers   5. Manuals   6. Controllers (PLCs etc.)   7. Sensors and actuators |
| 1. Methods of Assessment. | ***Competency may be assessed through:***   * 1. Practical test   2. Oral questioning   3. Interview   4. Case studies   5. Written test |
| 1. Context of Assessment. | * 1. Competency may be assessed individually in an actual workplace or in work-simulated conditions within accredited institutions or during industrial attachment. |
| 1. Guidance information for assessment. | * 1. Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |