

**COMPETENCY BASED CURRICULUM**

**FOR**

**MECHATRONIC TECHNOLOGY**

**LEVEL 5**



TVET CDACC

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NAIROBI

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# FOREWORD

The provision of quality education and training is fundamental to the Government’s overall strategy for social economic development. Quality education and training will contribute to achievement of Kenya’s development blueprint, 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 this curriculum has been developed.

It is my conviction that this curriculum will play a great role towards development of competent human resource for the Mechatronic 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 labour force.

The TVET Curriculum Development, Assessment and Certification Council (TVET CDACC), in conjunction with Mechatronic Sector Skills Advisory Committee (SSAC have developed this curriculum for Mechatronic Technology Level 5.

This curriculum has been developed following the CBET framework policy; the CBETA standards and guidelines provided by the TVET Authority and the Kenya National Qualification Framework designed by the Kenya National Qualification Authority.

I am grateful to the Council Members, Council Secretariat, Mechatronic SSAC, expert workers and all those who participated in the development of this curriculum

**CHAIRPERSON,**

**TVET CDACC**

# ACKNOWLEDGMENT

This CBET curriculum was developed through combined effort of various stakeholders from private and public organizations. I am 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 the curriculum.

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

I acknowledge all other institutions, which in one way or another contributed to the development of this curriculum.

**COUNCIL SECRETARY/CEO**

**TVET CDACC**

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# 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**

**HO /CU /MC /BC /01/ 6/ A**

Industry or sector

Occupational Standards

Occupational area

Type of competency

Competency number

Competency level

Version control

# COURSE DESCRIPTION

The units of Learning comprising Mechatronic Technology 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.

This course contains below units of learning

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BASIC UNITS OF COMPETENCY** | | | | |
| **Unit of Learning Code** | **Units of Learning Title** | **Duration in Hours** | | **Credits Factors** |
| **ENG/CU/MC/BC/01/5/A** | Communication skills | 25 | | 2.5 |
| **ENG/CU/MC/BC/02/5/A** | Digital literacy | 45 | | 4.5 |
| **ENG/CU/MC/BC/03/5/A** | Entrepreneurial skills | 70 | | 7 |
| **ENG/CU/MC/BC/04/5/A** | Employability skills | 50 | | 5 |
| **ENG/CU/MC/BC/05/5/A** | Environmental literacy | 25 | | 2.5 |
| **ENG/CU/MC/BC/06/5/A** | Occupational health and safety | 25 | | 2.5 |
| **TOTAL** | | **240** | | **24** |
| **COMMON UNITS OF COMPETENCY** | | | | |
| **ENG/CU/MC/CC/01/5/A** | Technical drawing | 80 | 8 | |
| **ENG/CU/MC/CC/02/5/A** | Applying engineering mathematics | 90 | 9 | |
| **ENG/CU/MC/CC/03/5/A** | Applying electrical and electronics principles | 70 | 7 | |
| **ENG/CU/MC/CC/04/5/A** | Workshop processes and practices | 60 | 6 | |
| **TOTAL** | | **300** | **30** | |
| **CORE UNITS OF COMPETENCY** | | | | |
| **ENG/CU/MC/CR/01/5/A** | Installing mechatronic systems | 60 | | 6 |
| **ENG/CU/MC/CR/02/5/A** | Maintaining electro-mechanical systems | 70 | | 7 |
| **ENG/CU/MC/CR/03/5/A** | Mechatronic systems instrumentation and control | 60 | | 6 |
| **ENG/CU/MC/CR/04/5/A** | Operating robotic and automated systems | 70 | | 7 |
| **ENG/CU/MC/CR/05/5/A** | Operating pneumatic and hydraulic systems | 50 | | 5 |
| **ENG/CU/MC/CR/06/5/A** | Operating programmable logic control (PLC) systems | 50 | | 5 |
| **ENG/CU/MC/CR/07/5/A** | Industrial attachment | 360 | | 36 |
| **TOTAL** | | **700** | | **70** |
| **GRAND TOTAL** | | **1260** | | **126** |

1. **Entry Requirements**

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

1. Kenya Certificate of Secondary Education (K.C.S.E.) with a minimum mean grade of D+ (plus)

**Or**

1. Level 4 certificate in a related course with **one** year of continuous work experience

**Or**

1. Equivalent qualifications as determined by Kenya National Qualifications Authority (KNQA)
2. **Trainer qualification**

A trainer for this course should have a higher qualification than the level of this course

1. **Industrial attachment**

An individual enrolled in this course will be required to undergo an industrial attachment in a firm dealing with Mechatronic Engineering for a period of at least two (2) months. An individual enrolled in one of the units of learning will be required to undergo a one-month attachment in a mechatronic section dealing with the relevant competency required. Attachment will be undertaken upon completion of the course or the unit of learning.

1. **Assessment**

The course will be assessed at two levels: internally and externally. Internal assessment is continuous and is conducted by the trainer who is monitored by an internal accredited verifier while external assessment is the responsibility of TVET/CDACC.

1. **Certification**

A candidate will be issued with a Record of Achievement on demonstration of competence in a unit of competency. To attain the qualification Mechatronic Technician Level 5, the candidate must demonstrate competence in all the units of competency as given in qualification pack. TVET CDACC will issue these certificates in conjunction with training provider.

# BASIC UNITS OF LEARNING

## 

## COMMUNICATION SKILLS

**UNIT CODE:** ENG/CU/MC/BC/01/5/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Communication Skills

**Duration of Unit:** 25hours

**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 organisation.

**Summary of Learning Outcomes**

1. Meet communication needs of clients and colleagues
2. Contribute to the development of communication strategies
3. Conduct interviews
4. Facilitate group discussions
5. Represent the organization

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Meet communication needs of clients and colleagues | * Communication process * Modes of communication * Medium of communication * Effective communication * Barriers to communication * Flow of communication * Sources of information * Organizational policies * Organization requirements for written and electronic communication methods * Report writing * Effective questioning techniques (clarifying and probing) * Workplace etiquette * Ethical work practices in handling communication * Active listening * Feedback * Interpretation * Flexibility in communication | * Interview * Third party reports * Written texts |
| 1. Contribute to the development of communication strategies | * Dynamics of groups * Styles of group leadership * Openness and flexibility in communication * Communication skills relevant to client groups | * Written * Observation |
| 1. Conduct interviews | * Types of interview * Establishing rapport * Facilitating resolution of issues * Developing action plans | * Written * Observation |
| 1. Facilitate group discussions | * Identification of communication needs * Dynamics of groups * Styles of group leadership * Presentation of information * Encouraging group members participation * Evaluating group communication strategies | * Written * Observation |
| 1. Represent the organization | * Presentation techniques * Development of a presentation * Multi-media utilization in presentation * Communication skills relevant to client groups | * Observation * Written |

**Suggested Methods of Instruction**

* Role playing
* Viewing of related videos

**Recommended Resources**

* Desktop computers/laptops
* Internet connection
* Projectors
* Telephone

## DIGITAL LITERACY

**UNIT CODE:** ENG/CU/MC/BC/02/5/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Digital Literacy

**Duration of Unit:** 45 hours

**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.

**Summary of Learning Outcomes**

1. Identify computer software and hardware
2. Apply security measures to data, hardware, software in automated environment
3. Apply computer software in solving tasks
4. Apply internet and email in communication at workplace
5. Apply desktop publishing in official assignments
6. Prepare presentation packages

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify computer hardware and software | * Concepts of ICT * Functions of ICT * History of computers * Components of a computer * Classification of computers | * Written tests * Oral presentation * Observation |
| 1. Apply security measures to data, hardware and software | * Data security and control * Security threats and control measures * Types of computer crimes * Detection and protection against computer crimes * Laws governing protection of ICT | * Written tests * Oral presentation * Observation * Project |
| 1. Apply computer software in solving tasks | * Operating system * Word processing * Spread sheets * Data base design and manipulation * Data manipulation, storage and retrieval | * Oral questioning * Observation * Project |
| 1. Apply internet and email in communication at workplace | * Computer networks * Network configurations * Uses of internet * Electronic mail (e-mail) concept | * Oral questioning * Observation * Oral presentation * Written report |
| 1. Apply desktop publishing in official assignments | * Concept of desktop publishing * Opening publication window * Identifying different tools and tool bars * Determining page layout * Opening, saving and closing files * Drawing various shapes using DTP * Using colour pellets to enhance a document * Inserting text frames * Importing and exporting text * Object linking and embedding * Designing of various publications * Printing of various publications | * Oral questioning * Observation * Oral presentation * Written report * Project |
| 1. Prepare presentation packages | * Types of presentation packages * Procedure of creating slides * Formatting slides * Presentation of slides * Procedure for editing objects | * Oral questioning * Observation * Oral presentation * Written report * Project |

**Suggested Methods of Instruction**

* Demonstration
* Viewing of related videos
* Discussions
* Assignments
* Direct instructions

**Recommended Resources**

* Computers
* Other digital devices
* Printers
* Storage devices
* Internet access
* Computer software

## ENTREPRENEURIAL SKILLS

**UNIT CODE:** ENG/CU/MC/BC/03/5/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Entrepreneurship

**Duration of unit:** 70 hours

**Unit Description**

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

**Summary of Learning Outcomes**

* 1. Demonstrate understanding of an entrepreneur
  2. Demonstrate knowledge of entrepreneurship and self-employment
  3. Identify entrepreneurship opportunities
  4. Create entrepreneurial awareness
  5. Apply entrepreneurial motivation
  6. Develop innovative business strategies
  7. Develop Business plan

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Demonstrate knowledge of entrepreneurship and self-employment | * Importance of self-employment * Requirements for entry into self-employment * Role of an Entrepreneur in business * Contributions of Entrepreneurs to National development * Entrepreneurship culture in Kenya * Born or made entrepreneurs | * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Identify entrepreneurship opportunities | * Business ideas and opportunities * Sources of business ideas * Business life cycle * Legal aspects of business * Assessment of product demand * Business environment * Factors to consider when evaluating business environment * Technology in business | * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Create entrepreneurial awareness | * Forms of businesses * Sources of business finance * Factors in selecting source of business finance * Governing policies on Small Scale Enterprises (SSEs) * Problems of starting and operating SSEs | * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Apply entrepreneurial motivation | * Internal and external motivation * Motivational theories * Self-assessment * Entrepreneurial orientation * Effective communications in entrepreneurship * Principles of communication * Entrepreneurial motivation | * Case studies * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Develop business innovative strategies | * Innovation in business * Small business Strategic Plan * Creativity in business development * Linkages with other entrepreneurs * ICT in business growth and development | * Case studies * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |
| 1. Develop Business Plan | * Business description * Marketing plan * Organizational/Management * plan * Production/operation plan * Financial plan * Executive summary * Presentation of Business Plan | * Case studies * Individual/group assignments * Projects * Written tests * Oral questions * Third party report * Interviews |

**Suggested Methods of instruction**

* Direct instruction
* Project
* Case studies
* Field trips
* Discussions
* Demonstration
* Question and answer
* Problem solving
* Experiential
* Team training

**Recommended Resources**

* Case studies
* Business plan templates
* Computers
* Overhead projectors
* Internet
* Mobile phone
* Video clips
* Films
* Newspapers and Handouts
* Business Journals
* Writing materials

## EMPLOYABILITY SKILLS

**UNIT CODE:** ENG/CU/MC/BC/04/5/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Employability Skills

**Duration of Unit:** 50 hours

**Unit Description**

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

**Summary of Learning Outcomes**

1. Conduct self-management

2. Demonstrate interpersonal communication

3. Demonstrate critical safe work habits

4. Lead small teams

5. Plan and organize work

6. Maintain professional growth and development

7. Demonstrate workplace learning

8. Demonstrate problem solving skills

9. Demonstrate workplace ethics

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Conduct self-management | * Self-awareness * Formulating personal vision, mission and goals * Strategies for overcoming life challenges * Emotional intelligence * Assertiveness versus aggressiveness * Expressing personal thoughts, feelings and beliefs * Developing and maintaining high self-esteem * Developing and maintaining positive self-image * Articulating ideas and aspirations * Accountability and responsibility * Good work habits * Self-awareness * Self-development * Financial literacy * Healthy lifestyle practices | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate interpersonal communication | * Meaning of interpersonal communication * Listening skills * Types of audience * Writing skills * Reading skills * Meaning of empathy * Understanding customers’ needs * Establishing communication networks * Sharing information | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate critical safe work habits | * Stress and stress management * Punctuality and time consciousness * Leisure * Integratingpersonal objectives into organizational objectives * Resources utilization * Setting work priorities * HIV and AIDS * Drug and substance abuse * Handling emerging issues | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Lead a small team | * Leadership qualities * Team building * Determination of team roles and objectives * Team performance indicators * Responsibilities in a team * Forms of communication * Complementing team activities * Gender and gender mainstreaming * Human rights * Maintaining relationships * Conflicts and conflict resolution | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Plan and organize work | * Functions of management * Planning * Organizing * Time management * Decision making process * Task allocation * Evaluating work activities * Resource utilization * Problem solving * Collecting and organising information | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Maintain professional growth and development | * Opportunities for professional growth * Assessing training needs * Licenses and certifications for professional growth and development * Pursuing personal and organizational goals * Identifying work priorities * Recognizing career advancement | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate workplace learning | * Managing own learning * Contributing to the learning community at the workplace * Cultural aspects of work * Variety of learning context * Application of learning * Safe use of technology * Identifying opportunities * Generating new ideas * Workplace innovation * Performance improvement * Handling emerging issues * Future trends and concerns in learning | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate problem solving skills | * Problem identification * Problem solving * Application of problem-solving strategies * Resolving customer concerns | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |
| 1. Demonstrate workplace ethics | * Meaning of ethics * Ethical perspectives * Principles of ethics * Values and beliefs * Ethical standards * Organization code of ethics * Common ethical dilemmas * Organization culture * Corruption, bribery and conflict of interest * Privacy and data protection * Diversity, harassment and mutual respect * Financial responsibility/accountability * Etiquette * Personal and professional integrity * Commitment to jurisdictional laws * Emerging issues in ethics | * Written tests * Oral questioning * Interviewing * Portfolio of evidence * Third party report |

**Suggested Methods of Instruction**

* Demonstrations
* Simulation/Role play
* Discussion
* Presentations
* Case studies
* Q&A

**Recommended Resources**

* Computers
* Stationery
* Charts
* Video clips
* Audio tapes
* Radio sets
* TV sets
* LCD projectors

## ENVIRONMENTAL LITERACY

**UNIT CODE:** ENG/CU/MC/BC/05/5/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Environmental Literacy

**Duration of Unit:** 25 hours

**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.

**Summary of Learning Outcomes**

1. Control environmental hazards
2. Control environmental Pollution
3. Demonstrate sustainable use of resource
4. Evaluate current practices in relation to resource usage
5. Identify Environmental legislations/conventions for environmental concerns
6. Implement specific environmental programs
7. Monitor activities on Environmental protection/Programs

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Control environmental hazards | * Purposes and content of Environmental Management and Coordination Act 1999 * Purposes and content of Solid Waste Act * Storage methods for environmentally hazardous materials * Disposal methods of hazardous wastes * Types and uses of PPE in line with environmental regulations * Occupational Safety and Health Standards (OSHS) | * Written test * Oral questions * Observation |
| 1. Control environmental Pollution control | * Types of pollution * Environmental pollution control measures * Types of solid wastes * Procedures for solid waste management * Different types of noise pollution * Methods for minimizing noise pollution | * Written test * Oral questions * Observation |
| 1. Demonstrate sustainable resource use | * Types of resources * Techniques in measuring current usage of resources * Calculating current usage of resources * Methods for minimizing wastage * Waste management procedures * Principles of 3Rs (Reduce, Reuse, Recycle) * Methods for economizing or reducing resource consumption | * Written test * Oral questions * Observation |
| 1. Evaluate current practices in relation to resource usage | * Collection of information on environmental and resource efficiency systems and procedures, * Measurement and recording of current resource usage * Analysis and recording of current purchasing strategies. * Analysis of current work processes to access information and data * Identification of areas for improvement | * Written test * Oral questions * Observation |
| 1. Identify Environmental legislations/conventions for environmental concerns | * Environmental issues/concerns * Environmental legislations /conventions and local ordinances * Industrial standard /environmental practices * International Environmental Protocols (Montreal, Kyoto) * Features of an environmental strategy | * Written questions * Oral questions * Observation |
| 1. Implement specific environmental programs | * Community needs and expectations * Resource availability * 5 s of good housekeeping * Identification of programs/Activities * Setting of individual roles /responsibilities * Resolving problems /constraints encountered * Consultation with stakeholders | * Written questions * Oral questions * Observation |
| 1. Monitor activities on Environmental protection/Programs | * Periodic monitoring and Evaluation of activities * Gathering feedback from stakeholders * Analysing data gathered * Documentation of recommendations and submission * Setting of management support systems to sustain and enhance the program * Monitoring and reporting of environmental incidents to concerned /proper authorities | * Oral questions * Written tests * Practical test * Observation |

**Suggested Methods of Instruction**

* Instructor led facilitation of theory
* Demonstration by trainer
* Viewing of related videos
* Project
* Assignements
* Role play

**Recommended Resources**

* Standard operating and/or other workplace procedures manuals
* Specific job procedures manuals
* Environmental Management and Coordination Act 1999
* Machine/equipment manufacturer’s specifications and instructions
* Personal Protective Equipment (PPE)
* ISO standards
* Ccompany environmental management systems (EMS)
* Montreal Protocol
* Kyoto Protocol

## OCCUPATIONAL SAFETY AND HEALTH PRACTICES

**UNIT CODE:** ENG/CU/MC/BC/06/5/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Demonstrate occupational safety and health practices

**Duration of Unit:** 25 hours

**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

**Summary of Learning Outcomes**

1. Identify workplace hazards and risk
2. Control OSH hazards
3. Implement OSH programs

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify workplace hazards and risks | * Identification of hazards in the workplace and/or the indicators of their presence * Evaluation and/or work environment measurements of OSH hazards/risk existing in the workplace is conducted by * Authorized personnel or agency * Gathering of OHS issues and/or concerns raised | * Oral questions * Written tests * Portfolio of evidence * Third party report |
| 1. Control OSH hazards | * Prevention and control measures, including use of PPE (personal protective equipment) for specific hazards are identified and implemented * Appropriate risk controls based on result of OSH hazard evaluation is recommended * Contingency measures, including emergency procedures during workplace incidents and emergencies are recognized and established in accordance with organization procedures | * Oral questions * Written tests * Portfolio of evidence * Third party report |
| 1. Implement OSH programs | * Providing information to work team about company OHS program, procedures and policies/guidelines * Participating in implementation of OSH procedures and policies/ guidelines * Training of team members and advice on OSH standards and procedures * Implementation of procedures for maintaining OSH-related records | * Oral questions * Written tests * Portfolio of evidence * Third party report |

**Suggested Methods of Instruction**

* Assigments
* Discussion
* Q&A
* Role play
* Viewing of related videos

**Recommended Resources**

* Standard operating and/or other workplace procedures manuals
* Specific job procedures manuals
* Machine/equipment manufacturer’s specifications and instructions
* Personal Protective Equipment (PPE) e.g.
* Mask
* Face mask/shield
* Safety boots
* Safety harness
* 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

# COMMON UNITS OF LEARNING

## TECHNICAL DRAWING

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Prepare and interpret technical drawings

**Duration of Unit: 80 Hours**

**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.

**Summary of Learning Outcomes**

1. Use and maintain drawing equipment and materials
2. Produce plain geometry drawings
3. Produce solid geometry drawings
4. Produce pictorial and orthographic drawings of components
5. Produce assembly drawings
6. Apply CAD software

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Use and maintain drawing equipment and materials | * Identification and maintain of drawing equipment and materials * Identification and maintain of drawing materials | * Oral questioning * Written tests * Practical |
| 1. Produce plain geometry drawings | * Lettering in drawing * Types of lines in drawings * Construction of geometric forms * Construction of different angles * Measurement of different angles * Standard drawing conventions | * Oral questioning * Written tests * Practical |
| 1. Produce solid geometry drawings | * Interpretation of sketches and drawings of patterns   + Cylinders   + Prisms   + Pyramids * Development of surface of interpenetrating solids and truncated solids * Interpenetrations of solids   + Cylinder to cylinder,   + Cylinder to prism,   + Prism to prism of equal and unequal diameters | * Written tests * Oral questioning * Practical |
| 1. Produce pictorial and orthographic drawings of components | * Meaning of pictorial and orthographic drawings and sectioning * Meaning of symbols and abbreviations * Drawing of isometric, oblique, axonometric, auxiliary and perspective views * Drawing of first and third angle projections * Sectioning of components * Free hand sketching of tools, equipment, components, geometric forms and diagrams | * Written test * Oral test * Practical |
| 1. Produce assembly drawings | * Explosion of orthographic views * Explosion of pictorial views * Identification and listing of parts * Production of sectional views * Hatching of drawings | * Written test * Oral test * Practical |
| 1. Apply CAD software in drawing | * Meaning and types of CAD e.g. * Auto CAD * Archi CAD * Solid works * Inventor * Circuit maker * Electronic work bench * 2D and 3D drafting technique * Annotation of models | * Practical * Written tests * Practical |

**Suggested methods of Instruction**

* Demonstration
* Field trips
* Discussions

**Recommended Resources**

* + Drawing room
  + Computer lab
  + Drawing equipment and materials
  + Computers
  + CAD package
  + Projector

## ENGINEERING MATHEMATICS

**UNIT CODE:** ENG/CU/MC/CC/02/5/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Apply engineering mathematics**

Duration of Unit: 90 hours

**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, applying complex numbers, coordinate geometry, carrying out binomial expansion, calculus, statistics, vector theory, matrix and numerical methods in solving problems, probability, commercial calculations, performing estimations, measurements and calculation of quantities.

**Summary of Learning Outcomes**

1. Apply Algebra
2. Apply Trigonometry and hyperbolic functions
3. Apply complex numbers
4. Apply Coordinate Geometry
5. Carry out Binomial Expansion
6. Apply Calculus
7. Apply Statistics
8. Apply Vector theory
9. Apply Matrix
10. Apply Numerical methods
11. Apply concept of probability for work
12. Perform commercial calculations
13. Perform Estimations, Measurements and calculations of quantities

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

|  |  |  |
| --- | --- | --- |
| **Electrical Curriculum** | | |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * 1. Apply Algebra | * Base and Index * Law of indices * Indicial equations * Laws of logarithm * Logarithmic equations * Conversion of bases * Use of calculator * Reduction of equations * Solution of equations reduced to quadratic form * Solutions of simultaneous linear equations in three unknowns * Solutions of problems involving AP and GP | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Apply Trigonometry and hyperbolic functions | * Half -angle formula * Factor formula * Trigonometric functions * Parametric equations * Relative and absolute measures * Measures calculation * Meaning of hyperbolic equations * Properties of hyperbolic functions * Evaluations of hyperbolic functions Hyperbolic identities * Osborne’s Rule * Ashx+bshx=C equation | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Apply complex numbers | * Meaning of complex numbers * Stating complex numbers in numbers in terms of conjugate argument and * Modulus * Representation of complex numbers on the Argand diagram * Arithmetic operation of complex numbers. * Application of De Moivre’s theorem * Application of complex numbers to engineering | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * 1. Apply Coordinate Geometry | * Polar equations * Cartesian equation * Graphs of polar equations * Normal and tangents * Definition of a point * Locus of a point in relation to a circle * Loci of points for given mechanism | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Carry out Binomial Expansion | * Binomial theorem determination of Roots of numbers using. * Estimation of errors of small changes using binomial theorem. * Binomial expansion in deriving power series. | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Apply Calculus | * Meaning of derivatives of a function * Differentiation from first principle i.e. sin x, cos x, xn and ln x * Tables of some common derivatives * Rules of differentiation i.e. product, chain, quotient, sum, implicit * Rate of change and small change * Stationery points of functions of two variables * Meaning of integration * Indefinite and definite integral * Methods of integration application of integration i.e integration by parts, substitution, polynomials, inverse functions. * Integrals of hyperbolic and inverse functions | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * 1. Apply Statistics | * Classification of data * Grouped data * Ungrouped data * Data collection * Importance of sampling * Errors in sapling * Types of sampling and their limitations * Tabulation of data * Class intervals * Class boundaries * Frequency tables * Diagrammatic and graphical presentation of data e.g. * Histograms * Frequency polygons * Bar charts * Pie charts * Cumulative frequency curves * Measures of central tendency mean, mode and median * Measures of dispersion * Variance and standard deviation * Definition of probability * Laws of probability * Expectation variance and S.D. * Types of distributions * Mean, variance and SD of probability distributions * Application of probability distributions | * Assignments * Oral questioning * Supervised exercises * Written tests * Simulation * Data modelling |
| * 1. Apply Vector theory | * Definition of dot and cross product of vectors * Solution of problems involving dot and cross production of cross * Definition of operators * Definition of vector field * Solutions of problems involving vector fields * Definition of Gradient, Divergence and curl * Solutions of involving Gradient, Divergence and curl * Application of vectors * Green’s, gauss’ and stoke’s theorems and their application. | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * 1. Apply Matrix methods | * Matrix operation * Determinant of 3x3 matrix * Inverse of 3x3 matrix * Solutions of linear simultaneous equations in 3 unknowns * Calculations of Eigen values and Eigen vectors * Application of matrices | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * 1. Apply Numerical methods | * Meaning of interpolation and extrapolation * Application of interpolation * Application of interactive methods to solve equations * Application of interactive methods to areas and volumes | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * 1. Apply concepts of probability in work | * + Probability * Laws of probability   + Expectation variance and standard derivation   + Types of distributions   + Mean, variance and standard derivation of probability distribution.   + Types of probability events * Dependent * Independent * Mutually exclusive   + Laws of probability   + Counting techniques * Permutation * Combination * Tree diagrams * Venn diagrams | * Written tests * Assignments * Supervised exercises |
| * 1. Perform commercial calculations | * + Product pricing   + Average sales determination   + Stock turnover   + Calculation of incomes   + Profit and loss calculations   + Salaries * Gross * Net   + Wages * Time rate * Flat rate * Overtime * Piece rate * Commission * Percentage * Bonus   + Conversion of one currency to another   + Exchange rates calculation * Devaluation * Revaluation | * Oral questioning * Written tests * Assignments * Supervised exercises |
| * 1. Perform estimations, measurements and calculations of quantities | * Units of measurements and their symbols * Conversion of units of measurement * Calculation of length, width, height, perimeter, area and angles of figures * Measuring tools and equipment * Measurements and estimations of quantities e.g. Areas and volumes using papas theorem. | * Assignments * Oral questioning * Practical tests * Observation * Supervised exercises * Written tests |

**Suggested methods of instructions**

* Group discussions
* Demonstration by trainer
* Exercises by trainee

**Recommended Resources**

* Scientific Calculators
* Rulers, pencils, erasers
* Charts with presentations of data
* Graph books
* Dice
* Computers with internet connection
* Standard mathematical tables.

## ELECTRICAL AND ELECTRONICS PRINCIPLES

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Apply electrical and electronics principles**

**Duration of Unit:** 70 hours

**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

**Summary of Learning Outcomes**

1. Use the concept of basic Electrical quantities
2. Use the concepts of D.C and A.C circuits in electrical installation
3. Use of basic electrical machine
4. Carry out power rectification in electrical systems
5. Use of earthing in Electrical installations
6. Apply lightning protection measures

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Use the concept of basic Electrical quantities | * The meaning of SI unit * SI unit of various types of Electrical parameters * Calculations involving various Electrical parameters e.g. Power, Current, Voltage, Resistance * Instruments used in measuring various types of Electrical parameters | * Written tests * Oral questioning * Assignments |
| 1. Use the concepts of D.C and A.C circuits in electrical installation | * Ohm’s law * Definition of terms * Parallel and series circuits * AC and DC network theorems | * Written tests * Oral questioning * Assignments |
| 1. Use of basic electrical machine | * Types of Electrical machines * AC and DC single and three phase motors, generators and Transformers * Application of AC and DC machines | * Oral questioning * Written tests |
| 1. Carry out power rectification in electrical systems | * Power rectification methods * Half wave rectifiers * Full wave rectifiers * Full wave Wheatstone bridge * Definition of terms * Power smooth * Power training techniques * Power regulation methods * Power protection methods and devices * Switches * Fuses * Circuit breakers | * Written tests * Oral questioning * Assignments |
| 1. Use of earthing in Electrical installations | * + Meaning of Earthing   + Terms in Earthing   + Earthing points in Electrical installation   + Methods of earthing   + Factors to consider in selecting an earthing method   + Testing an earthing system | * Assignments * Written tests * Practical test |
| 1. Apply lightning protection measures | * + Meaning of lightening   + Lightening strokes and their types   + Lightening protection components   + Testing a lightening system   + Application of lightening system   + Maintenance of lightening system | * Assignments * Oral questioning * Written tests |

**Suggested Methods of Instruction**

* Discussions
* Demonstration

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* Electrical workshop
* Relevant practical materials
* Dice
* Computers with internet connection

## WORKSHOP PROCESSES AND PRACTICES

**UNIT CODE:** ENG/CU/MC/CC/04/5/A

**Relationship to Occupational Standards:**

This unit addresses the unit of competency: Perform workshop processes and practices

Duration of Unit: **60 Hours**

**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

**Summary of Learning Outcome**

1. Use technical drawing to plan work operations
2. Measure and mark out dimensions on work pieces
3. Use hand tools to cut and file parts
4. Use drills to make holes
5. Thread using taps and dies
6. Produce components using a lathe and milling machine
7. Perform surface finish
8. Assemble metal parts and sub-assemblies
9. Perform housekeeping
10. Inspect finished work for accuracy and quality
11. Maintenance of tools and equipment

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Use technical drawing to plan work operations | * Producing technical drawings * Reading and extraction of information (dimensions, tolerances, BS/ANSI Drawing Standards, geometric ISO symbols & abbreviations) * Development of working procedure/ operational plan | * Practical Test * Oral Questioning * Written Test |
| 1. Measure and mark out dimensions on work pieces | * Selection of measuring tools and marking tools * Steel rule * Vernier calipers * Micrometer screw gauge * Punch * scribers * Inspection and calibration of measuring tools * Marking out of dimensions on the work-piece | * Practical Test * Oral Questioning * Written Test t |
| 1. Use hand tools to cut and file parts | * Selection of the appropriate hand tools * Claw Hammer * Chisel * Hacksaw * File * Screw drivers * Hand drill * Vise etc. * Cutting of the work-piece * Filing of the cut work-piece * Production of all the parts | * Practical Test * Oral Questioning * Written Test |
| 1. Use drills to make holes | * Marking of hole * Centre punching of hole centers * Selection and mounting of drill bits * Mounting and clamping of the work-piece * Drilling of holes * Inspection of drilled holes | * Practical Test * Oral Questioning * Written Test |
| 1. Thread using taps and dies | * Selection of taps and dies * Clamping of work-piece * Setting up taps and dies on the work-piece * Cutting of threads | * Practical Test * Oral Questioning * Written Test |
| 1. Produce components using a lathe and milling machine | * Selection of the right tool * Cutting tool * Boring tool * Knurling tool * Drilling tool * Boring tool * Threading tool * Parting tool * Tool post grinding * Facing of work-piece on the lathe machine * Turning of work-piece * Threading of work-piece * Boring of work-piece * Knurling * Parting of work-piece * Drilling of work-piece * Gear cutting on milling machine * Plane/slab milling * Face milling * Side milling * Angular milling * Gang milling * Form milling * Sprocket cutting | * Practical Test * Oral Questioning * Written Test |
| 1. Assemble metal parts and sub-assemblies | * Joinery and assembly method selection * Welding * Use of adhesives * Riveting * Use of screws, bolts and nuts * Soldering * Brazing etc * Joining, fitting and assembling * Quality control (Dimensions, Tolerances, surface finishing, Alignment) | * Practical Test * Oral Questioning * Written Test |
| 1. Performing finishing processes | * Finishing * Polishing * Filing * Grinding * de-burring * painting of components | * Practical Test * Oral Questioning * Written Test |
| 1. Performing housekeeping | * Cleaning of work environment (waste sorting and disposal) * Cleaning and storing of tools and equipment * Servicing and maintenance of machine (lubrication, inspection, alignment and adjustment) | * Practical Test * Oral Questioning * Written Test |
| 1. Inspect finished work for accuracy and quality | * Selection of inspections methods and tools * Inspection of finished product * Adjustment of product to required specification | * Practical Test * Oral Questioning * Written Test |
| 1. Maintenance of tools and equipment | * Inspection of machines and tools * Lubrication of machines and tools * Grinding of tools before storage * Identification of faulty machines and broken tools | * Practical Test * Oral Questioning * Written Test |

**Suggested Methods of Instruction**

* Demonstration by trainer
* Discussions
* Practical work by trainee(s)
* Exercises
* Industrials visits
* Internet.
* Simulation

**List of Recommended Resources**

* Welding
* Drilling machines
* Vices
* Burnishing machine
* Cutting tools
* Combination square
* Centre punch
* Centre lathe
* scribers
* calipers
* Dies and taps
* Surface plate
* V-blocks
* Dial gauge
* Die stock
* Engineer’s square
* File card
* Assorted Files
* Clamps
* Assorted hand tools
* Hammers
* Measuring tools
* Drill bits
* Assorted inspection tools and equipment
* Inspection and measuring tools, GO and NOT GO gauges
* Jigs and fixture
* Pliers
* Rotary disc abrasive grinder
* Reamers
* Saw
* Screwdrivers
* Spiral lowering
* Tap wrench
* Vacuum cleaners
* V-block
* Workbenches
* Vacuum cleaners
* Mops/ Brooms and buckets
* Firefighting equipment
* First Aid kit
* Personal safety gear:
* Goggles
* Safety shoes
* Overall
* Cap
* Ear Muffs
* Gloves
* Drawing papers
* Raw materials
* Mild steel plate
* Sheet metal
* Brass sheets
* Zinc sheets
* Aluminum sheets
* Bright Drawn Mild Steel
* Carbon steel
* Brass rods
* Aluminum rods
* Abrasive materials
* Grinding paste
* Cotton wastes
* Cleaning detergents

# CORE UNITS OF LEARNING

## INSTALLING MECHATRONIC SYSTEMS

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Install Mechatronic Systems**

**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.

**Duration of Unit:** 60 hours

**Summary of Learning Outcomes**

1. Install system wiring
2. Install electrical devices
3. Install piping system
4. Install mechanical system
5. Install electronic systems
6. Install sensing devices in mechatronic system

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Install system wiring | * + Types tools and equipment for wiring   + Types of cables, conductors and colour coding   + Electrical joints and termination   + Electrical symbols   + Electrical wiring accessories and equipment   + Electrical circuit diagrams   + Wiring layouts   + Electrical installations   Domestic wiring  Industrial wiring   * + Electrical regulations and standards   + Inspection and testing | * Practical test * Written test * Oral questioning |
| 1. Install electrical devices | * + Tools and equipment for electrical device installation   + DC machines installation   + AC machines installation   Motor rewinding tools  Dismantling and assembly of motors  Motor rewinding   * + Electrical device testing   + Solar systems   + Assembly of basic electronic circuits   Amplifier circuits  Inverter and convertor circuit  Power supply and regulator circuits | * Practical test * Written test * Oral questioning |
| 1. Install piping system | * + Types of pipes * Cast iron pipes * PVC pipes * Galvanized steel pipes * Concrete pipes * High density polyethylene pipes * Asbestos pipes   + Piping materials and properties   + Pipe bending techniques   + Types of piping joints   + Piping diagrams   + Pipe assembly | * Practical test * Written test * Oral questioning |
| 1. Install mechanical system | * Hydraulics systems   + Interpretation of Process and instrumentation diagrams (P&ID)   + Parts of hydraulic systems   + Pressure gauges   + Oil grades of a hydraulic system   + Sealing of hydraulic systems * Pneumatic systems   + Types of compressors   + Valves   + Cylinders * Heat generators, heat exchangers * Pumps and turbines * Coupling of mechanical drives and machines with mechatronic systems * Erection and commissioning procedures | * Practical test * Written test * Oral questioning |
| 1. Install electronic systems | * Installation of electronic equipment in mechatronic system * Analogue electronics * Amplifiers * Filters * Oscillators * Signal processing * Digital electronics * Logic gates and Boolean algebra * Multiplexers and decoders * Installation of D.C drives in mechatronic system * Identification and installation of Digital displays and indicators * LED displays * Liquid Crystal Displays * 7-segment displays * Organic displays * Installation of monitoring and control systems * Testing of electronic equipment | * Practical test * Written test * Oral questioning |
| 1. Install sensing devices in mechatronic system | * Identification of tools and equipment * Identification of sensors * Temperature sensors * Pressure sensors * Proximity sensors * Angle sensors * Vibration sensors * Light sensors * Smoke sensors * Installation of sensors * Sensor connection diagrams * Sensor drivers * Installation of calibration equipment * Testing of sensors * Interfacing sensors with mechatronic system | * Practical test * Written test * Oral questioning |

**Suggested Methods of Instruction**

* Presentations
* Demonstrations
* Guided learner activities
* Supervised activities and projects in a workshop;
* Visiting lecturer/trainer from the mechatronics service and repair sector;
* Industrial visits.

**Recommended Resources**

* A fully equipped mechatronic workshop
* Fully functional sensor modules
* Electronic modules
* control modules
* Driver modules
* Hydraulic valves
* Hydraulic cylinders
* Compressors
* Pneumatic systems
* Testing and measuring instruments modules
* A.C and D.C drives
* Power supply modules
* Solar panels and batteries
* Pipe bending and threading machines
* Holding vices
* Welding machines
* A.C and D.C motors
* Internet access to manufacturers’ technical information;
* Torque setting tools;
* Personal protective equipment (PPE) and suitable coverings to machines
* Facilities for the disposal of waste oil and used parts;
* Cables and conductors
* Pipes and conduits
* Electrical accessories
* Oils and lubricants
* Electronic components
* Oil seals and gaskets;
* Drive belts.

## MAINTAINING ELECTRO-MECHANICAL SYSTEMS

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Maintain Electro-Mechanical Systems**

**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.

**Duration of Unit:** 70 hours

**Summary of Learning Outcomes**

1. Troubleshoot electro-mechanical faults
2. Service and/or repair electrical system
3. Service and/or repair mechanical system faults
4. Test electro-mechanical system
5. Schedule maintenance of electro-mechanical system

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Troubleshoot electro-mechanical faults | * + Trouble shooting techniques   + Electrical technical diagrams   + Mechanical technical diagrams   + Types of tools and equipment   + Electro-mechanical circuits   + Functionality of electro-mechanical systems | * Written test * Oral questioning * Practical test |
| 1. Service and/or repair electrical system | * + Inspection methods in electrical systems   + Types of tools and equipment in electrical service and repair   + Electrical assembly and disassembly   + Instrumentation and measurement of electrical quantities   + Service and repair documentation and reporting   + Electrical machine drive systems   + Cables and wire terminations | * Written test * Oral questioning * Practical test |
| 1. Service and/or repair mechanical systems | * + Inspection methods in mechanical systems   + Mechanical assembly and disassembly   + Oils and lubricants used in joint and moving parts   + Fault detection indicators     - Noise     - Bends     - Heating   + Mechanical machine drive systems   + Service and repair documentation and reporting   + Types of tools and equipment in mechanical service and repair   + Joint and links in mechanical drives   + Bearings, keys and key ways | * Written test * Oral questioning * Practical test |
| 1. Test electro-mechanical system | * + Preparation and application of test-run checklist   + Diagnostic equipment and instrumentation   + Equipment calibration   + Identification of systems to be tested including:   + battery and charging;   + oils and lubricants   + starters, emergency stop buttons   + energy management systems;   + pressure and temperature systems;   + lighting;   + electrical and electronics;   + joints and linkages;   + Diagnostic test standard procedures   + Machine adjustment and manipulation   + Fault rectification for optimal system performance   + Documentation of test result and reporting | * Written test * Oral questioning * Practical test |
| 1. Schedule maintenance of electro-mechanical system | * + Types of maintenance   + Regular maintenance scheduling   + Reasons for performing maintenance   + Maintenance documentation   + Reliability of maintenance   + Maintenance software   + Activity tracking and logging   + Plan for break down maintenance | * Written test * Oral questioning * Practical test |

**Suggested Methods of Instruction**

* Presentations
* Demonstrations
* Guided learner activities
* Supervised activities and projects in a workshop;
* Visiting lecturer/trainer from the motor vehicle service and repair sector;
* Industrial visits.

**Recommended Resources**

* Comprehensive set of hand and power tools for industrial maintenance and repair.
* Electrical testing tools
* A fully equipped electro-mechanical parts store;
* Electrical testing equipment
* Lifts and ladders;
* Hoists and cranes
* Diagnostic equipment appropriates for electro-mechanical system repair and maintenance;
* Lighting stands;
* Torque setting tools;
* Personal protective equipment (PPE) and suitable coverings to protect electro-mechanical equipment;
* Facilities for the disposal of waste oil, lubricants and used parts;
* Oils and lubricants;
* Bearings
* Seals and gaskets
* Bolts
* Nuts
* Screws
* Thread tapes
* Washers
* Cables and wiring
* Fuses
* Connectors
* Capacitors
* Batteries
* Resistors
* Diodes
* Shrink-wraps
* Electrical Insulating tapes
* Air, oil, exhaust, and air conditioning filters;
* Drive belts.
* Motors
* Chains
* Gears
* Rollers
* Bearings

## MECHATRONIC SYSTEMS INSTRUMENTATION AND CONTROL MAINTENANCE

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Maintain Mechatronic systems instrumentation and control**

**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, analyse instrumentation and control data and service and/or repair system faults

**Duration of Unit:** 60 hours

**Summary of Learning Outcomes**

1. Document the control system design and specifications
2. Install mechatronic instrumentation and control system
3. Analyse instrumentation and control data
4. Service and/or repair mechatronic system

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Design a control system | * Definition of mechatronic system problem to be controlled * Modelling of Circuit diagrams for the control system * Analysis of models and determination of their properties * Selection of control variables (outputs/inputs) * Selection of controller type and its configuration * Design of a controller * Selection and inspection of controller components * Customization of mechatronic system * Hardware and software in control systems * Simulation of controlled mechatronic system * Testing and calibration of controlled mechatronic system * Design manual development | * Observation * Written test * Oral questioning * Practical |
| 1. Document the control system design and specifications | * Developing of technical report * Developing of operation and maintenance manual * Patenting | * Practical test * Oral questioning * Observation * Written test |
| 1. Install mechatronic instrumentation and control system | * Selection of installation tools and equipment * Interfacing of controller and mechatronic system * Studying, monitoring, testing and evaluating system performance * Calibration of mechatronic systems * Commissioning of mechatronic system. * Variable speed drives | * Practical * Oral questioning * Observation * Written test |
| 1. Analyse instrumentation and control data | * Data selection * Data collection and documentation * Data analysis | • Practical  • Oral questioning  • Observation  • Written test |
| 1. Service and/or repair mechatronic system | * Tools and equipment are selection * System testing and fault diagnosis * Standard service and repair procedures * Maintenance scheduling * Reporting and documentation | • Practical  • Oral questioning  • Observation  • Written test |

**Suggested Methods of Instruction**

* Presentations
* Demonstrations by trainer;
* Guided learner activities
* Supervised activities and projects in a workshop;
* Visiting lecturer/trainer from the mechatronics service and repair sector;
* Industrial visits.

**Recommended Resources**

Comprehensive set of hand tools and power tools

* Actuators
* Electronic modules
* control modules
* Driver modules
* Testing and measuring instruments modules
* A.C and D.C drives
* Power supply module
* A.C and D.C motors
* Internet access to manufacturers’ technical information;
* Personal protective equipment (PPE) and suitable coverings to machines
* Facilities for the disposal of waste oil and used parts;
* Cables and conductors
* Pipes and conduits
* Electrical accessories
* Oils and lubricants
* Electronic components
* Oil seals and gaskets;
* Drive belts.
* PLC modules
* Drivers and Software
* Computer modules
* Variable speed/frequency drive (VSD/VFD)

## ROBOTIC AND AUTOMATED SYSTEMS OPERATIONS

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Operate Robotic and Automated Systems**

**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

**Duration of Unit:** 70 hours

**Summary of Learning Outcomes**

1. Interpret installation manuals
2. Install robotic and automated systems
3. Integrate robotic and automated system to existing system
4. Test and Commission mechatronic system
5. Service and maintain robotic and automated system faults

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Install robotic and automated systems | * Planar and spatial mechanics * Introduction to robotics and automation * Inspection of robotic and automated system * Assembly of robotic and automated system components * Interfacing of control systems to mechatronic and automated system * System programming, debugging, testing and uploading * Robotic and automated system operations. | * Observation * Written test * Oral questioning * Practical test |
| 1. Integrate robotic and automated system to existing system | * Feasibility analysis * System architecture development * System integration techniques * Calibration * System configuration management | * Practical * Oral questioning * Observation * Written test |
| 1. Test and Commission mechatronic system | * Testing tools and equipment * Robotic and automated system parameters * Monitoring, evaluation and assessment of system performance * System commissioning * Human resource development | * Practical test * Oral questioning * Observation * Written test |
| 1. Service and maintain robotic and automated system faults | * System Fault diagnosis * Robotic and automated system service and repair * system service and maintenance reporting and documentation * maintenance scheduling | * Practical test * Oral questioning * Observation * Written test |

**Suggested Methods of Instruction**

* Presentations and practical demonstrations by trainer;
* Guided learner activities and research to develop underpinning knowledge;
* Supervised activities and projects in a workshop;
* Visiting lecturer/trainer from the mechatronics service and repair sector;
* Industrial visits.

**Recommended Resources**

* Robotics arms
* Actuators
* Electronic modules
* control modules
* Driver modules
* Hydraulic valves
* Hydraulic cylinders
* Compressors
* Pneumatic systems
* Testing and measuring instruments modules
* A.C and D.C drives
* Power supply module
* Holding vices
* Welding machines
* A.C and D.C motors
* Internet access to manufacturers’ technical information;
* Personal protective equipment (PPE) and suitable coverings to machines
* Cables and conductors
* Pipes and conduits
* Electrical accessories
* Oils and lubricants
* Electronic components
* Oil seals and gaskets;
* Drive belts.
* PLC modules
* Drivers and Software
* Computer modules
* Mechanical fasteners
* Electrical fittings
* Facilities for the disposal of waste oil and used parts;

## PNEUMATIC AND HYDRAULIC SYSTEMS

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Operate Pneumatic and Hydraulic Systems**

**Unit description**

This unit describes the competencies required by a technician in order to operate a 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.

**Duration of Unit:** 50 hours

**Summary of Learning Outcomes**

1. Install pneumatic and hydraulic systems
2. Test and inspect pneumatic and hydraulic systems
3. Integrate and verify pneumatic and hydraulic system parameters
4. Service and maintain pneumatic and hydraulic systems
5. Redesign existing systems with hydraulic/ pneumatic systems

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

|  |  |  |
| --- | --- | --- |
| **LEARNING OUTCOME** | **CONTENT** | **Suggested Assessment Methods** |
| 1. Install pneumatic and hydraulic systems | * Introduction to pneumatics and hydraulic systems * Layout of pneumatics and hydraulic systems * Components of pneumatics and hydraulic systems * Types and properties of Pneumatics and hydraulic systems fluids * Tools and equipment used in pneumatics and hydraulic system installation * Pneumatics and hydraulic system symbols and technical drawing * Pneumatics and hydraulic system instrumentation | * Observation * Written test * Oral questioning * Practical |
| 1. Test and inspect pneumatic and hydraulic systems | * + Standard procedures of testing and inspection   + hydraulic and pneumatic system fluid contaminants * Diagnostic tools and equipment and instrumentation used in testing and inspection of hydraulic and pneumatic systems * Pneumatic and hydraulic system calibration and manipulation * Fault detection indicators and rectification:   + Noise   + Bends   + Heating   + Leakages   + vibration * Identifying systems to be tested and/or inspected:   + Fluids parameters   + Gauges and valves   + Joints   + Seals and gaskets   + Filters   + Documentation of test and inspection results and reporting | * Observation * Written test * Oral questioning * Practical |
| 1. Integrate and verify pneumatic and hydraulic system parameters | * + Hydraulic and pneumatic fluid parameters   + Gauges and instruments in Hydraulic and pneumatic systems   + Energy flow in Hydraulic and pneumatic systems   + Hydraulic and pneumatic actuators   + Hydraulic and pneumatic connection types and layouts | * Observation * Written test * Oral questioning * Practical |
| 1. Service and maintain pneumatic and hydraulic systems | * Working with pressurized equipment * Pneumatic and hydraulic machine drive systems * Tools and equipment used in Service and maintenance of pneumatic and hydraulic systems * Types of maintenance * Maintenance scheduling and planning * Maintenance documentation * Maintenance reliability * Inspection methods of pneumatic and hydraulic systems * Pneumatic and hydraulic systems assembly and disassembly | * Observation * Practical * Written test * Oral questioning |
| 1. Redesign existing systems with hydraulic/ pneumatic systems | * Pneumatic and hydraulic system applications * Integration of Pneumatic and hydraulic systems in existing systems * Conventional drive systems   + Belts and pulley   + Camshafts   + Chain drives   + Electrical machine drives   + Manual shut off valves systems * Design of Pneumatic and hydraulic machine drive systems | * Observation * Practical test * Written test * Oral questioning |

**Suggested Methods of Instruction**

* Presentations and practical demonstrations by trainer;
* Guided learner activities;
* Supervised activities and projects in a workshop;
* Visiting lecturer/trainer from the motor vehicle service and repair sector;
* Industrial visits.

**Recommended Resources**

* Comprehensive set of hand tools for assembly and disassembly of programmable units.
* Hydraulic and pneumatic leakage testing tools
* Instruments and gauges
* Directional control valves
* Pneumatic and hydraulic components and pumps
* Compressors
* Reservoirs
* Hydraulic and pneumatic presses and jacks
* Pipe bending equipment
* Hydraulic and pneumatic supply units
* Purification equipment
* Hydraulic and pneumatic cylinders
* Hydraulic and pneumatic control valves
* Hydraulic and pneumatic motors
* Seals and gaskets
* Lids
* Valves
* Piping and connectors
* Joints
* Hydraulic fluids
* Electrical and mechanical peripherals

## PROGRAMMABLE LOGIC CONTROL (PLC) SYSTEMS

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Operate Programmable Logic Control systems.

**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.

**Duration of Unit:** 50 hours

**Summary of Learning Outcomes**

1. Install PLC system
2. Apply tug-out on PLC system
3. Install application software
4. Test and configure I/O modules, sensors, and PLC unit
5. Diagnose faults on PLC system
6. Maintain PLC system

Learning Outcomes, Content and Suggested Assessment Methods

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Install PLC system | * Introduction to PLCs * Linear/structured programming techniques * Installation techniques and components * PLC and electrical circuit diagrams * PLC wiring * Hardware handling, configuration and addressing of signal modules * Identification, assembly and networking of peripheral devices * PLC networking * PLC peripheral devices | * Practical test * Observation * Written test * Oral questioning |
| 1. Apply tug-out on PLC system | * Recognition PLC wires and cables * Setting manual switches * Tugging out methods | * Practical test * Observation * Written test * Oral questioning |
| 1. Install application software | * Network data communication * PLC software * Formatting of PLC system software and hardware * Software installation | * Practical test * Observation * Written test * Oral questioning |
| 1. Test and configure I/O modules, sensors, and PLC unit | * Types of system configurations * PLC software configuration * PLC hardware configuration * CPU and peripheral devices testing * Input and output modules * Memories and storage systems | * Practical test * Observation * Written test * Oral questioning |
| 1. Diagnose faults on PLC system | * Methods of fault detection * Diagnostic reasoning for logic control faults * Diagnostic reasoning for sequential faults * Diagnostic reasoning for logic programming * PLC logic control * Program debugging | * Practical test * Observation * Oral questioning * Written test |
| 1. Maintain PLC system | * PLC system and peripheral devices cleaning * Temperature control * Calibration of analogue * Replacing of faulty equipment and devices | * Practical test * Oral questioning * Observation * Written test |

**Suggested Methods of Instruction**

* Presentations and practical demonstrations by trainer;
* Guided learner activities
* Supervised activities and projects in a workshop;
* Visiting lecturer/trainer from the mechatronics service and repair sector;
* Industrial visits.

**Recommended Resources**

* Fully equipped mechatronic lab
* A.C to D.C power supply
* Compressor systems
* Pneumatics systems
* PLC modules
* Projector
* Measuring instruments
* Bending machines
* Welding and fabrication machines
* Holding vices
* Computer modules
* Cables and conductors
* Electrical accessories
* Oils and lubricants
* Electronic components
* Oil seals and gaskets;
* Drive belts.
* PLC modules
* Drivers and Software
* Variable speed/frequency drive (VSD/VFD)
* Electrical and mechanical limit switches