

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

**COMPETENCY BASED CURRICULUM**

**FOR**

**MECHATRONIC TECHNOLOGY**

**LEVEL 6**



TVET CDACC

P.O BOX 15745-00100

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 Kenya’s development blue print and sustainable development goals.

Reforms in the education sector are necessary for the achievement of Kenya Vision 2030 and meeting the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution and this resulted to the formulation of the Policy Framework for Reforming Education and Training. A key feature of this policy is the radical change in the design and delivery of the TVET training. This policy document requires that training in TVET be competency based, curriculum development be industry led, certification be based on demonstration of competence and mode of delivery allows for multiple entry and exit in TVET programmes.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that 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 sustainable development.

**PRINCIPAL SECRETARY, VOCATIONAL AND TECHNICAL TRAINING**

**MINISTRY OF EDUCATION**

# PREFACE

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

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

TVET Curriculum Development, Assessment and Certification Council (TVET CDACC) in conjunction with Mechatronic Sector Skills Advisory Committee (SSAC) and other stakeholders have developed this curriculum.

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.

The curriculum is designed and organized with an outline of learning outcomes; suggested delivery methods, training/learning resources and methods of assessing the trainee’s achievement. The curriculum is competency-based and allows multiple entry and exit to the course.

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

**Prof. CHARLES M. M. ONDIEKI, PhD, FIET (K), Con. EngTech.**

**CHAIRPERSON, TVET CDACC**

# ACKNOWLEDGMENT

This curriculum has been designed for competency-based training and has independent units of learning that allow the trainee flexibility in entry and exit. In developing the curriculum, significant involvement and support was received from various organizations.

I appreciate Mechatronic Sector Skills Advisory Committee (SSAC) who enabled the development of this curriculum.

I recognize with appreciation the role of the SSAC in ensuring that competencies required by the industry are addressed in this curriculum. I also thank all stakeholders in the Mechatronic sector for their valuable input and all those who participated in the process of developing this curriculum.

I am convinced that this curriculum will go a long way in ensuring that workers in Mechatronic sector will acquire competencies that will enable them to perform their work more efficiently.

**Dr. LAWRENCE GUANTAI M’ITONGA, PhD**

**COUNCIL SECRETARY/CEO**

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# ACRONYMS

TVET: Technical and Vocational Education and Training

CDACC: Curriculum Development, Assessment and Certification Council

ICT: Information communication technology

SSAC: Sector Skill Advisory Committee

EIA: Environmental Impact Assessment

CBET: Competency Based Education and Training

PPE: Personal Protective Equipment

EMS: Environmental Management System

OSH: Occupational Safety and Health

OSHA: Occupational, Health and Safety Act

CAD: Computer Aided Design

D.C: Direct Current

A.C: Alternating Current

PLC: Programmable Logic Control

VSD: Variable Speed Drive

I/O: Input/output

# KEY TO UNIT CODE

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

Industry or sector

Occupational Standards

Occupational area

Type of competency

Competency number

Competency level

Version control

# COURSE DESCRIPTION

Mechatronic Technology Certificate Level 6 qualification consists of competencies that an individual must achieve to enable him/her to work in the mechatronic sector. It entails designing of electro-mechanical systems, installing mechatronic systems, maintaining electro-mechanical systems, mechatronic systems instrumentation and control, mechatronic programming, operating mechatronic systems and managing mechatronic projects.

|  |
| --- |
| **BASIC UNITS OF COMPETENCY** |
| **Unit of Learning Code**  | **Units of Learning Title**  | **Duration in Hours**  | **Credits Factors** |
| **ENG/CU/MC/BC/01/6/A** | Communication skills | 40 | 4 |
| **ENG/CU/MC/BC/02/6/A** | Digital literacy | 60 | 6 |
| **ENG/CU/MC/BC/03/6/A** | Entrepreneurial skills | 100 | 10 |
| **ENG/CU/MC/BC/04/6/A** | Employability skills | 80 | 8 |
| **ENG/CU/MC/BC/05/6/A** | Environmental literacy | 40 | 4 |
| **ENG/CU/MC/BC/06/6/A** | Occupational health and safety | 40 | 4 |
| **TOTAL** | **360** | **36** |
| **COMMON UNITS OF COMPETENCY** |
| **ENG/CU/MC/CC/01/6/A** | Technical drawing | 160 | 16 |
| **ENG/CU/MC/CC/02/6/A** | Applying engineering mathematics | 150 | 15 |
| **ENG/CU/MC/CC/03/6/A** | Performing workshop processes and practices | 60 | 6 |
| **ENG/CU/MC/CC/04/6/A** | Applying electrical and electronics principles | 80 | 8 |
| **ENG/CU/MC/CC/05/6/A** | Applying material science principles | 60 | 6 |
| **ENG/CU/MC/CC/06/6/A** | Applying thermodynamics principles | 60 | 6 |
| **ENG/CU/MC/CC/07/6/A** | Applying fluid mechanics principles | 70 | 7 |
| **TOTAL** | **640** | **64** |
| **CORE UNITS OF COMPETENCY** |
| **ENG/CU/MC/CR/01/6/A** | Designing of electro-mechanical systems | 120 | 12 |
| **ENG/CU/MC/CR/02/6/A** | Installing mechatronic systems | 150 | 15 |
| **ENG/CU/MC/CR/03/6/A** | Maintaining electro-mechanical systems | 150 | 15 |
| **ENG/CU/MC/CR/04/6/A** | Mechatronic systems instrumentation and control | 120 | 12 |
| **ENG/CU/MC/CR/05/6/A** | Mechatronic programming | 140 | 14 |
| **ENG/CU/MC/CR/06/6/A** | Operate mechatronic systems | 130 | 13 |
| **ENG/CU/MC/CR/07/6/A** | Managing mechatronic projects | 120 | 12 |
| **ENG/CU/MC/CR/08/6/A** | Industrial attachment | 480 | 48 |
| **TOTAL**  | **1450** | **145** |
| **GRAND TOTAL** | **2400** | **240** |

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 C- (C minus)

**Or**

1. Level 5 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. **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 three (3) months. An individual enrolled in one of the units of learning will be required to undergo a one-month attachment in a Mechatronic department 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 6, 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/01/6/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Demonstrate communication skills

**Duration of Unit:** 40 hours

**Unit Description**

This unit covers the competencies required in meeting communication needs of clients and colleagues and developing, establishing, maintaining communication pathways and strategies. It also covers competencies for conducting interview, facilitating group discussion and representing the organization in various forums.

**Summary of Learning Outcomes**

1. Utilize specialized communication skills processes
2. Develop communication strategies
3. Establish and maintain communication pathways
4. Promote use of communication strategies
5. Conduct interview
6. Facilitate group discussion
7. Represent the organization

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Utilize specialized communication skills processes
 | * 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
* Types of communication strategies
* Elements of communication strategy
 | * Written
* Oral
 |
| 1. Develop communication strategies
 | * Dynamics of groups
* Styles of group leadership
* Openness and flexibility in communication
* Communication skills relevant to client groups
 | * Observation
* Written
 |
| 1. Establish and maintain communication pathways
 | * Types of communication pathways
 | * Written
* Observation
 |
| 1. Promote use of communication strategies
 | * Application of elements of communication strategies
* Effective communication techniques
 | * Written
* Observation
 |
| 1. Conduct interview
 | * Types of interview
* Establishing rapport
* Facilitating resolution of issues
* Developing action plans
 | * Written
* Observation
 |
| 1. Facilitate group discussion
 | * 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 Delivery Methods**

* Interview
* Role playing
* Observation

**Recommended Resources**

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

##

## DIGITAL LITERACY

**UNIT CODE: ENG/CU/MC/BC/02/6/A**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate digital literacy

**Duration of Unit:** 60 hours

**Unit Description**

This unit describes competencies required to use a computer and other digital devices for the purposes of communication, work performance and management at the workplace.

**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 Delivery Methods**

* Instructor led facilitation of theory
* Demonstration by trainer
* Practical work by trainee
* Viewing of related videos
* Project
* Group discussions

**Recommended Resources**

* Desk top computers
* Laptop computers
* Other digital devices
* Printers
* Storage devices
* Internet access
* Computer software

##

## ENTREPRENEURIAL SKILLS

**UNIT CODE: ENG/CU/MC/BC/03/6/A**

**Relationship to occupational standards**

This unit addresses the unit of competency: Demonstrate entrepreneurial skills

**Duration of unit:** 100 hours

**Unit description**

This unit describes the competencies critical to demonstration of entrepreneurial aptitudes. It involves, developing business innovation strategies, developing new markets, customer base, expanding employed capital and undertaking regional/county expansion while retaining motivated staff.

**Summary of Learning Outcomes**

1. Develop business innovation strategies
2. Develop new products/ markets
3. Expand customers and product lines
4. Motivate all staff/workers
5. Expand employed capital base
6. Undertake regional/county business expansion

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Develop business Innovation strategies
 | * Innovation in business
* Business innovation strategies
* Creativity for business development
* New technologies in entrepreneurship
* Linkages with other entrepreneurs
* Setting strategic directions
* New ideas and approaches
* Entrepreneurial skills development
* Market trends
* Monitoring and anticipating market trends
* Products and processes in entrepreneurship
* Business conventions ad exhibitions
* Business growth refocus
 | * Observation
* Case studies
* Individual/group assignments
* projects
* Written
* Oral
 |
| 1. Develop new products/ markets
 | * Feasibility study for new products
* Identifying new sources of raw material and resources
* New target markets/customers
* Increasing products and services
* Marketing improvement
* Intrapreneurship and business growth
 | * Observation
* Case studies
* Individual/group assignments
* projects
* Written
* Oral
 |
| 1. Expand customers and product lines
 | * Market demand
* Regulatory environment
* Creating product and services competitive advantages
* Creating royal client base
* Identifying and maintain new customers and markets
* Advance product/ service promotions
* Advance market expansion
* Small business records management
* Book keeping and auditing for small businesses
* Computer application software and programmes
* ICT in customer and product diversification
 | * Oral
* Observation
* Case studies
* Individual/group assignments
* projects
* Written
 |
| 1. Motivate staff/workers
 | * Motivation of workers
* Communication at workplace for motivation purpose
* Problem solving
* Conflict resolution at place of work
* Good staff/workers relation
* Team building and team work
* Staff development and enhancement
* Culture of continuous improvement
 | * Observation
* Case studies
* Individual/group assignments
* projects
* Written
 |
| 1. Expand employed capital base
 | * Employed capital in business
* Business share holdings
* Types of shares
* Shares diversification
* Role of shareholders
* Entrepreneurship
* Increasing products and services
 | * Observation
* Case studies
* Individual/group assignments
* projects
* Written
* Oral
 |
| 1. Undertake county/ regional business expansion
 | * Region/ county identification process
* Regional/ county laws and regulation
* Business regional/county expansion
* Regional/ County business expansion
* Innovation in business
* Business expansion and diversification
* Resources for regional/county expansion
* Small business Strategic Plan
* Computer software in business development
* ICT and business growth
 | * Observation
* Case studies
* Individual/group assignments
* projects
* Written
* Oral
 |

**Suggested Delivery Methods**

* Instructor led facilitation of theory
* Demonstration by trainer
* Practice by trainee
* Role play
* Case study

**Recommended Resources**

* Case studies for small businesses
* Business plan templates
* Laptop/ desktop computers
* Internet
* Telephone
* Writing materials

##

## EMPLOYABILITY SKILLS

**UNIT CODE: ENG/CU/MC/BC/04/6/A**

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate employability skills

**Duration of Unit:** 80 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 ethical performance.

**Summary of Learning Outcomes**

1. Conduct self-management
2. Demonstrate interpersonal communication
3. Demonstrate critical safe work habits
4. Lead a workplace team
5. Plan and organize work
6. Maintain professional growth and development
7. Demonstrate workplace learning
8. Demonstrate problem solving skills
9. Manage ethical performance

**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
* Managing emotions
* Emotional intelligence
* Assertiveness versus aggressiveness
* Expressing personal thoughts, feelings and beliefs
* Developing and maintaining high self-esteem
* Developing and maintaining positive self-image
* Setting performance targets
* Monitoring and evaluating performance
* Articulating ideas and aspirations
* Accountability and responsibility
* Good work habits
* Self-awareness
* Values and beliefs
* Self-development
* Financial literacy
* Healthy lifestyle practices
* Adopting safety practices
 | * Observation
* Written
* Oral interview
* Third party report
 |
| 1. Demonstrate interpersonal communication
 | * Meaning of interpersonal communication
* Listening skills
* Types of audience
* Public speaking
* Writing skills
* Negotiation skills
* Reading skills
* Meaning of empathy
* Understanding customers’ needs
* Establishing communication networks
* Assertiveness
* Sharing information
 |  |
| 1. Demonstrate critical safe work habits
 | * Stress and stress management
* Time concept
* Punctuality and time consciousness
* Leisure
* Integratingpersonal objectives into organizational objectives
* Resources mobilization
* Resources utilization
* Setting work priorities
* Developing healthy relationships
* HIV and AIDS
* Drug and substance abuse
* Managing emerging issues
 | * Observation
* Written
* Oral interview
* Third party report
 |
| 1. Lead a workplace team
 | * Leadership qualities
* Power and authority
* Team building
* Determination of team roles and objectives
* Team parameters and relationships
* Individual responsibilities in a team
* Forms of communication
* Complementing team activities
* Gender and gender mainstreaming
* Human rights
* Developing healthy relationships
* Maintaining relationships
* Conflicts and conflict resolution
* Coaching and mentoring skills
 | * Observation
* Oral interview
* Written
* Third party report
 |
| 1. Plan and organize work
 | * Functions of management
* Planning
* Organizing
* Time management
* Decision making concept
* Task allocation
* Developing work plans
* Developing work goals/objectives and deliverables
* Monitoring work activities
* Evaluating work activities
* Resource mobilization
* Resource allocation
* Resource utilization
* Proactive planning
* Risk evaluation
* Problem solving
* Collecting, analysing and organising information
* Negotiation
 | * Observation
* Oral interview
* Written
* Third party report
 |
| 1. Maintain professional growth and development
 | * Avenues for professional growth
* Training and career opportunities
* Assessing training needs
* Mobilizing training resources
* Licenses and certifications for professional growth and development
* Pursuing personal and organizational goals
* Managing work priorities and commitments
* Recognizing career advancement
 | * Observation
* Oral interview
* Written
* Third party report
 |
| 1. Demonstrate workplace learning
 | * Managing own learning
* Mentoring
* Coaching
* Contributing to the learning community at the workplace
* Cultural aspects of work
* Networking
* Variety of learning context
* Application of learning
* Safe use of technology
* Taking initiative/proactivity
* Flexibility
* Identifying opportunities
* Generating new ideas
* Workplace innovation
* Performance improvement
* Managing emerging issues
* Future trends and concerns in learning
 | * Observation
* Oral interview
* Written
* Third party report
 |
| 1. Demonstrate problem solving skills
 | * Critical thinking process
* Data analysis tools
* Decision making
* Creative thinking
* Development of creative, innovative and practical solutions
* Independence in identifying and solving problems
* Solving problems in teams
* Application of problem-solving strategies
* Testing assumptions
* Resolving customer concerns
 | * Observation
* Oral interview
* Written
* Third party report
 |
| 1. Manage ethical performance
 | * Meaning of ethics
* Ethical perspectives
* Principles of ethics
* 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
 | * Observation
* Oral interview
* Written
* Third party report
 |

**Suggested Methods of Delivery**

* Instructor lead facilitation of theory
* Demonstrations
* Simulation/Role play
* Group Discussion
* Presentations
* Projects
* Case studies
* Assignments

**Recommended Resources**

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

##

## ENVIRONMENTAL LITERACY

**UNIT CODE**: **ENG/CU/MC/BC/05/6/A**

**Relationship to Occupational Standards**:

This unit addresses the unit standard: **Demonstrate environmental literacy**

**Duration of Unit:** 40 hours

**Unit Description**

This unit describes the competencies required to control environmental hazard, control environmental pollution, comply with workplace sustainable resource use, evaluate current practices in relation to resource usage, identify environmental legislations/conventions for environmental concerns, implement specific environmental programs, monitor activities on environmental protection/programs, analyse resource use and develop resource conservation plans.

**Summary of Learning Outcomes**

1. Control environmental hazard
2. Control environmental Pollution
3. Demonstrate sustainable resource use
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
8. Analyze resource use
9. Develop resource conservation plans

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** |  **Content** | **Suggested Assessment Methods** |
| 1. Control environmental hazard
 | * Purposes and content of Environmental Management and Coordination Act 1999
* 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 questions
* Oral questions
* Observation of work procedures
 |
| 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 questions
* Oral questions
* Observation of work procedures
* Role play
 |
| 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 questions
* Oral questions
* Observation of work procedures
* Role play
 |
| 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 questions
* Oral questions
* Observation of work procedures
* Role play
 |
| 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 of work procedures
 |
| 1. Implement specific environmental programs
 | * Community needs and expectations
* Resource availability
* 5s of good housekeeping
* Identification of programs/Activities
* Setting of individual roles /responsibilities
* Resolving problems /constraints encountered
* Consultation with stakeholders
 | * Written questions
* Oral questions
* Observation of work procedures
* Role play
 |
| 1. Monitor activities on Environmental protection/Programs
 | * Periodic monitoring and Evaluation of activities
* Gathering feedback from stakeholders
* Analyzing 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
 |
| 1. Analyze resource use
 | * Identification of resource consuming processes
* Determination of quantity and nature of resource consumed
* Analysis of resource flow through different parts of the process.
* Classification of wastes for possible source of resources.
 | * Written tests
* Oral questions
* Practical test
* Observation
 |
| 1. Develop resource Conservation plans
 | * Determination of efficiency of use/conversion of resources
* Causes of low efficiency of use of resources
* Plans for increasing the efficiency of resource use
 | * Written tests
* Oral questions
* Practical test
* Observation
 |

**Suggested Delivery Methods**

* Instructor led facilitation of theory
* Practical demonstration of tasks by trainer
* Practice by trainees
* Observations and comments and corrections by trainers

**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
* Company environmental management systems (EMS)
* Montreal Protocol
* Kyoto Protocol

##

## OCCUPATIONAL SAFETY AND HEALTH PRACTICES

**UNIT CODE:** **ENG/CU/MC/BC/06/6/A**

**Relationship to Occupational Standards**

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

**Duration of Unit:** 40 hours

**Unit Description**

This unit describes the competencies required to comply with regulatory and organizational requirements for occupational safety and health.

**Summary of Learning Outcomes**

1. Identify work place hazards and risk
2. Identify and implement appropriate control measures to hazards and risks
3. Implement OSH programs, procedures and policies/guidelines

**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
* Gathering of OSH issues and/or concerns
 | * Oral questions
* Written tests
* Observation of trainees identify hazards and risks
 |
| 1. Identify and implement appropriate control measure to hazards and risks
 | * Prevention and control measures e.g. use of PPE
* Contingency measures
 | * Oral questions
* Written tests
* Practical tests
* Observation of implementation of control measures
 |
| 1. Implement OSH

 programs, procedures and policies/guidelines | * Company OSH program, procedures and policies/guidelines
* 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
* Practical test
* Observation
 |

**Suggested Delivery Methods**

* Instructor led facilitation of theory
* Demonstration by trainer
* Practical work by trainee
* 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/01/6/A**

**Relationship to Occupational Standards**

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

**Duration of Unit: 160 Hours**

**Unit Description**

This unit covers the competencies required to prepare and interpret technical drawings by a mechatronic technician. 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 softwares.

**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. 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
 | * Observation
* Oral questioning
* Written tests
 |
| 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
* Observation
 |
| 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
 | * Observation
* Written tests
* Oral questioning
 |
| 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
 | * Observation
* Written test
* Oral test
 |
| 1. Produce assembly drawings
 | * Explosion of orthographic views
* Explosion of pictorial views
* Identification and listing of parts
* Production of sectional views
* Hatching of drawings
 | * Observation
* Written test
* Oral test
 |
| 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
* Observation
* Written tests
 |

**Suggested Methods of Delivery**

* Projects
* Demonstration
* Practice by the trainee
* Field trips
* Group discussions
* Direct instructions

**Recommended Resources**

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

## ENGINEERING MATHEMATICS

**UNIT CODE: ENG/CU/MC/CC/02/6/A**

**Relationship to Occupational Standards**

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

Duration of Unit: 150 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, trigonometry and hyperbolic functions, complex numbers, coordinate geometry, binomial expansion, calculus, ordinary differential equations, Laplace transforms, power series, Statistics, Fourier series, vector theory, matrix, numerical methods, probability, commercial calculations, estimations and measurements in solving problems

**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. Solve Ordinary differential equations
8. Apply Laplace transforms
9. Apply Power Series
10. Apply Statistics
11. Apply Fourier Series
12. Apply Vector theory
13. Apply Matrix
14. Apply Numerical methods
15. Apply concept of probability for work
16. Perform commercial calculations
17. 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
* One-to-one relationship in functions
* Inverse functions for one-to-one relationship
* Inverse functions for trigonometric functions
* Graph of inverse functions
* Inverse hyperbolic functions
 | * 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 in determination of Roots of numbers
* 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
* Derivative of inverse functions
* 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. Solve Ordinary differential equations
 | * Types of first order differential equations
* Linear Differential Equations
* Homogeneous Equations
* Exact Equations
* Separable Equations
* Integrating Factor
* Formation of first order differential equation
* Solution of first order differential equations
* Application of first order differential equations
* Formation of second order differential equations for various systems
* Solution of second order differential equations
* Application of second order differential equations
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * 1. Apply Laplace transforms
 | * Meaning of Laplace transforms
* Deriving Laplace transforms from first principles
* State properties of Laplace transform
* Determination of inverse LT of simple transforms and partial fractions
* Solution of differential equation by LT
* Solution of simultaneous differential equation by given initial conditions
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * 1. Apply Power Series
 | * Meaning of the term power series
* Taylor’s theorem
* Deduction of Maclaurin’s theorem to obtain power series
* Application of Taylor’s theorem and Maclaurin’s theorems in numerical work
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * 1. Apply Statistics
 | * Classification of data
* Grouped data
* Ungrouped data
* Data collection
* Importance of sampling
* Errors in sampling
* Types of sampling and their limitations
* Tabulation of data
	+ Class intervals
	+ Class boundaries
	+ Frequency tables
	+ Cumulative frequency
* Diagrammatic and graphical presentation of data e.g.
	+ Histograms
	+ Frequency polygons
	+ Bar charts
	+ Pie charts
	+ Curves
* Measures of central tendency (mean, mode and median)
* Measures of dispersion
* Variance and standard deviation
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
* Simulation
* Data modelling
 |
| * 1. Apply Fourier Series
 | * Determination of the Fourier series as a periodic function of the period 2π and extend to π
* Determination of Fourier series of non-periodic functions over a given range
* Determination of Fourier series for even and odd functions and the half-range series for a given function
* Determination of Fourier series over any range
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |
| * 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’s and Stoke’s theorem 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 three 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 S.D.
* Types of distributions
* Mean, variance and S.D of probability distributions
	+ Types of probability events
* Dependent
* Independent
* Mutually exclusive
	+ Counting techniques
* Permutation
* Combination
* Tree diagrams
* Venn diagrams
	+ Application of probability distributions
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |
| 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 Pappus theorem
 | * Assignments
* Oral questioning
* Practical tests
* Observation
* Supervised exercises
* Written tests
 |

**Suggested Delivery Methods**

* 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

## WORKSHOP PROCESSES AND PRACTICES

**UNIT CODE: ENG/CU/MC/CC/03/6/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 technician 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. Thread using taps and dies
5. Produce components using a lathe and milling machine
6. Assemble metal parts and sub-assemblies
7. Perform housekeeping
8. Inspect finished work for accuracy and quality
9. 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
* Observation
* Written
 |
| 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
* Observation
* Written
 |
| 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 e.t.c
* Cutting of the work-piece
* Filing of the cut work-piece
* Production of all the parts
 | * Practical
* Observation
* Written
 |
| 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
* Observation
* Written
 |
| 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
* Observation
* Written
 |
| 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
* Observation
* Written
 |
| 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
* Observation
* Written
 |
| 1. Performing finishing processes
 | * Finishing
* Polishing
* Filing
* Grinding
* de-burring
* painting of components
 | * Observation
* Practical
* Observation
* Written
 |
| 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)
 | * Observation
* Practical
* Observation
* Written
 |
| 1. Inspect finished work for accuracy and quality
 | * Selection of inspections methods and tools
* Inspection of finished product
* Adjustment of product to required specification
 | * Observation
* Practical
* Observation
* Written
 |
| 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
 | * Written
* Oral
 |

**Suggested Delivery Methods**

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

**List of Recommended Resources**

**Tools and equipment suggested but not limited to:**

* 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

**Materials and supplies suggested but not limited to:**

* 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

## ELECTRICAL AND ELECTRONICS PRINCIPLES

**UNIT CODE: ENG/CU/MC/CC/04/6/A**

**Relationship to Occupational Standards**

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

**Duration of Unit:** 80 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 Delivery Methods**

* Group discussions
* Demonstration by trainer
* Exercises by trainee

**Recommended Resources**

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

## MATERIAL SCIENCE PRINCIPLES

**UNIT CODE: ENG/CU/MC/CC/05/6/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Apply material science principles**

**Duration of Unit:** 60 hours

**Unit Description**

This unit describes the competencies required by a mechatronic technician in order to apply a wide range of material science principles skills in their work. It involves analysing properties of engineering materials, utilising engineering materials, performing heat treatment, performing material testing and preventing material corrosion

**Summary of Learning Outcomes**

1. Analyse properties of engineering materials
2. Utilise engineering materials
3. Perform heat treatment
4. Perform material testing
5. Prevent material corrosion

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Analyse properties of engineering materials
 | * Identification of engineering materials
* Metals
* metal alloys
* polymers
* ceramics
* composites
* determination of physical properties of engineering materials
* determination of mechanical properties of materials
* Ductility
* Malleability
* Elasticity
* Toughness
* Hardness
* Brittleness
* Plasticity
* Strength
* Analysis of the crystal structures of materials
* Simple cubic
* BCC
* FCC
* HCP
 | * Written tests
* Oral questioning
 |
| 1. Utilise engineering materials
 | * Identification of engineering materials
* Development of operation plan
* Machine setup procedures
* Setting of production parameters
* Production methods and procedures
 | * Written tests
* Oral questioning
 |
| 1. Perform heat treatment
 | * Observation of safety procedures and practices
* Heat treatment processes
* Annealing
* Tempering
* Normalizing
* Hardening
* Case hardening
* Identification of heat treatment method
* Performing heat treatment
 | * Written tests
* Oral questioning
 |
| 1. Perform material testing
 | * Identification of material testing methods
* Compression test
* Hardness tests
* Tensile tests
* Brinel hardness tests
* Rockwell hardness test
* Impact tests
* Creep tests
* Bending tests
* Fatigue tests
* Torsional tests
* Sharing tests
* Preparation of work-piece for testing
* Setting up of equipment and work-piece
* Carrying out testing
* Tabulation, analysis and presentation of results
* Maintenance of the testing equipment
 | * Written tests
* Oral questioning
 |
| 1. Prevent material corrosion
 | * + Corrosion types identification
	+ Corrosion prevention methods definition and identification
	+ Application of corrosion prevention on work piece
 | * Written tests
* Practical test
 |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Exercises by trainee

**Recommended Resources**

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

THERMODYNAMICS PRINCIPLES

**UNIT CODE: ENG/CU/MC/CC/06/6/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply thermodynamics principles

**Duration of Unit: 60** hours

**UNIT DESCRIPTION**

This unit describes the competencies required by a mechatronic technician in order to apply thermodynamics principles in their work. It includes understanding fundamentals of thermodynamics, understanding compressed air cycles, understanding steam cycles, understanding steam engines, performing refrigeration, understand steam turbines

**Summary of Learning Outcomes**

1. Understand fundamentals of thermodynamics
2. Understand compressed air cycles
3. Understand steam cycles
4. Understand steam engines
5. Perform refrigeration
6. Understand steam turbines

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Understand fundamentals of thermodynamics
 | * + Terms used in thermodynamics
	+ Thermodynamics processes and cycles
* First law of thermodynamics
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| 1. Understand compressed air cycles
 | * + Operation principles of air compressors
* Air processes
	+ Types of air compressors
* Reciprocating compressors.
* Ionic liquid piston compressor.
* Rotary screw compressors.
* Rotary vane compressors.
* Rolling piston.
* Scroll compressors.
* Diaphragm compressors.
* Air bubble compressor.
	+ Calculations in air compressors
* work inputs
* compressor clearances
* varying outputs
* Performing multi-staging and intercooling of air compressors
* Types compressed air engines
* Single cylinder piston type
* Double crank link type
* Characteristics of two types of compressed air engines
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| 1. Understand steam cycles
 | * + The Rankine
* Cycle components
* Component efficiencies
* Cycle efficiency
* Engine efficiency
* Factors affecting efficiency – line loss
* Throttling
* Condenser pressure and temperature
	+ Reheat cycle
* Regenerative cycle
* Bleed cycle
* Combination cycle
* Cycle analysis
	+ Stream generation
* Types of boilers
* Feed water considerations
* Fuel and combustion principles
* Boiler efficiencies
	+ Steam cycle efficiencies
* Deviations from ideal
* Line losses
* Throttling heat losses
* Condensate temperatures
* Feed and air pre-heating
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |
| 1. Understand steam engines
 | * + Determining reciprocating engine principles
	+ Determining valves and timing methods
* Indictor diagrams
	+ Power calculations
* Effect of cut-off
* Back pressure
* Condensing and non-condensing
* Staging
* Single acting
* Double acting
* Referred pressures
	+ Calculation of ideal thermal and mechanical efficiency
* Determining of indicated and brake power
 | * Assignments
* Oral questioning
* Practical
* Supervised exercises
* Written tests
 |
| 1. Understand steam turbines
 | * + Determining Reaction and impulse
	+ Performing staging of steam turbines
	+ Performing velocity calculations
	+ Determining the turbine design considerations
	+ Calculation of ideal, thermal and mechanical efficiencies
	+ Determining factors affecting efficiencies
* Performing condensing arrangements of steam turbines
 | * Assignments
* Oral questioning
* Practical tests
* Observation
* Supervised exercises
 |
| 1. Perform refrigeration
 | * + Determining the Carnot cycle
* Vapour compression cycle
* Coefficient of performance
	+ Performing cycle analysis
* Plant output calculation
* Factors affecting efficiency
* Compression procedures
* Intercooling
* Sub-cooling
* Cascade staging
	+ Studying heat pumps
* Coefficient of performance heating
* Coefficient of performance cooling
	+ Determining absorption refrigeration systems
	+ Determination of steam jet refrigeration systems
 | * Assignments
* Oral questioning
* Observation
* Supervised exercises
 |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Online video clips
* Power point presentation
* Exercises by trainee

**Recommended Resources**

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

FLUID MECHANICS PRINCIPLES

**UNIT CODE: ENG/CU/MC/CC/07/6/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply fluid mechanics 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 fluid mechanics principles in their work. It includes understanding flow of fluids, demonstrating knowledge in viscous flow, performing dimensional analysis and operating fluid pumps.

**Summary of Learning Outcomes**

1. Understand flow of fluids
2. Demonstrate knowledge in viscous flow
3. Perform dimensional analysis
4. Operate fluid pumps

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Understand flow of fluids
 | * Flow rate in pipes
* Losses in pipes
* Causes of losses in pipes
* Application of flow loss equations
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| 1. Demonstrate knowledge in viscous flow
 | * Viscous flow between parallel surfaces
* Viscous flow equations
* Application of viscous flow equations
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| 1. Perform dimensional analysis
 | * + Dimensional analysis definition
	+ Principle of dimensional homogeneity
	+ Fundamental dimensions and units
	+ Physical quantities
* Application of dimensional analysis
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |
| 1. Operate fluid pumps
 | * + Principle of operation of pumps
	+ Reciprocating pump equation
	+ Centrifugal pump equation
	+ Application of pump equations in problem solving
 | * Assignments
* Oral questioning
* Practical tests
* Observation
* Supervised exercises
* Written tests
 |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Online video clips
* Power point presentation
* Exercises by trainee

**Recommended Resources**

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

# CORE UNITS OF LEARNING

## DESIGNING OF ELECTRO-MECHANICAL SYSTEMS

**UNIT CODE: ENG/CU/MC/CR/01/6/A**

**Relationship to Occupational Standards**

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

**Duration of Unit: 120** hours

 **Unit description**

This unit covers the competencies required to perform mechatronic systems instrumentation and control. It involves competencies to; observe occupational health and safety, identify problem and assess site, develop multiple model solutions to existing problem, simulate developed model, identify and select product design materials, document design work, monitor and evaluate design performance

 **Summary of Learning Outcomes**

1. Observe occupational health and safety
2. Identify problem and assess site
3. Develop multiple model solutions to existing problem
4. Simulate developed model
5. Identify and select product design materials
6. Document design work
7. Monitor and evaluate design performance

Learning Outcomes, Content and Suggested Assessment Methods

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Observe occupational health and safety
 | * Use of Personal protective equipment (PPE)
* ***Storage Tools and equipment***
* Tools and equipment are used correctly according to designated purpose
* Housekeeping workspace)
* Workplace is planning.
 | * Practical
* Observation
* Written
* Oral
 |
| 1. Identify problem and assess site
 | * Problem definition
* Breaking down of the problem to attainable tasks
* Obtaining site visit authorisation
* Site assessment
* Documentation of site findings
 | * Observation
* Written
* Oral
* Practical
 |
| 1. Develop multiple model solutions to existing problem
 | * Examination of existing solutions
* Generation of multiple ideas
* Gathering of Pertinent information
* Analysis of gathered information
* Selection of best working solution model
* Documentation of selected model
 | * Practical
* Oral
* Observation
* Written
 |
| 1. Simulate developed model
 | * Obtaining of modelling requirements
* Development of Model
* Simulation of Developed model
* Collection and documentation of simulation Data
* Redesigning of Models
 | * Practical
* Oral
* Observation
* Written
 |
| 1. Identify and select product design materials
 | * Identification of individual product components
* Identification of materials needed for the individual components
* Material analysis
* Product assembly
* Documentation of material specification
 | • Practical• Oral• Observation• Written |
| 1. Document design work
 | * Development of technical report
* Development of operation and maintenance manual
* Patenting of product design
 | • Practical• Oral• Observation• Written |
| 1. Monitor and evaluate design performance
 | * Gathering of feedback
* Data analysis
* Evaluation of product performance
* Generation of report
 | • Practical• Oral• Observation• Written |

**Suggested Methods of Delivery**

* Presentations and practical demonstrations by trainer;
* Guided learner activities and research to develop underpinning knowledge;
* Supervised activities and projects in a workshop;

The delivery may also be supplemented and enhanced by the following, if the opportunity allows:

* Visiting lecturer/trainer from the mechatronics service and repair sector;
* Industrial visits.

**Recommended Resources**

|  |
| --- |
| **Tools**Comprehensive set of hand tools and power tools |
| **Equipment** * 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
 |
| **Materials and supplies**Consumables for electrical installation* 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
 |
| **Reference materials**Manufacturers service manuals for all the modulesAppropriate electrical and mechanical engineering text books  |

## INSTALLING MECHATRONIC SYSTEMS

**UNIT CODE: ENG/CU/MC/CR/02/6/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Install mechatronic systems**

**Duration of Unit: 150** hours

 **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, install sensing devices in system, integrate mechatronic system in system and test and Commission mechatronic system

**Summary of Learning Outcomes**

1. Observe occupational health and safety
2. Install system wiring
3. Install electrical devices
4. Install piping system
5. Install mechanical system
6. Install electronic systems
7. Install sensing devices in mechatronic system
8. Integrate mechatronic system in an existing system
9. Test and Commission mechatronic system

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Observe occupational health and safety
 | * + Types and usage of PPE
	+ Industrial safety signs
	+ Safety standards
	+ Safety operations
	+ First aid
	+ Fire fighting
	+ House keeping
 | * Practical
* Observation
* Written
* Oral
 |
| 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 wiringIndustrial wiring* + Electrical regulations and standards
	+ Inspection and testing
 | * Observation
* Written
* Oral
* Practical
 |
| 1. Install electrical devices
 | * + Tools and equipment for electrical device installation
	+ DC machines installation
	+ AC machines installation

Motor rewinding toolsDismantling and assembly of motorsMotor rewinding* + Electrical device testing
	+ Solar systems
	+ Assembly of basic electronic circuits

Amplifier circuitsInverter and convertor circuitPower supply and regulator circuits | * Practical
* Oral
* Observation
* Written
 |
| 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
* Oral
* Observation
* Written
 |
| 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 exercises with observation checklists conducted by trainer.
* Oral questioning with checklist conducted by trainer to assess. Underpinning knowledge.
* Short answer written tests to assess underpinning knowledge.
 |
| 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 exercises with observation checklists conducted by trainer.
* Oral questioning with checklist conducted by trainer to assess underpinning knowledge.
* Short answer written tests to assess underpinning knowledge.
 |
| 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
* Oral
* Observation
* Written
 |
| 1. Integrate mechatronic system in an existing system
 | * + Inspection methods of individual components of mechatronic system
* Types of tools and equipment for assembly
* Assembly of components to form a mechatronic system
* Mechatronic system integration
 | * Practical
* Observations
 |
| 1. Test and Commission mechatronic system
 | * Identification of testing tools and equipment
* Testing of Mechatronic system
* Calibration of parameters
* Documentation of the system test results
* Commissioning of the mechatronic system
 | * Practical
* Oral
* Observation
* Written
 |

**Suggested Methods of Delivery**

* Presentations and practical demonstrations by trainer;
* Guided learner activities and research to develop underpinning knowledge;
* Supervised activities and projects in a workshop;

The delivery may also be supplemented and enhanced by the following, if the opportunity allows:

* Visiting lecturer/trainer from the mechatronics service and repair sector;
* Industrial visits.

**Recommended Resources**

|  |
| --- |
| **Tools**Comprehensive set of hand tools and power tools |
| **Equipment** * 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;
 |
| **Materials and supplies**Consumables for electrical installation* Cables and conductors
* Pipes and conduits
* Electrical accessories
* Oils and lubricants
* Electronic components
* Oil seals and gaskets;
* Drive belts.
 |
| **Reference materials**Manufacturers service manuals for all the modulesAppropriate mechatronic engineering text books available on numerous eBook websites  |

## MAINTAINING ELECTRO-MECHANICAL SYSTEMS

**UNIT CODE: ENG/CU/MC/CR/03/6/A**

**Relationship to Occupational Standards**

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

**Duration of Unit: 150** hours

**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.

**Summary of Learning Outcomes**

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

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Observe occupational health and safety
 | * Types and usage of PPE
* Industrial safety signs
* Safety standards
* Safety operations
* First aid
* Fire fighting
* House keeping
 | * Practical
* Observation
* Written
* Oral
 |
| 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
 | * Observation
* Written
* Oral
* Practical
 |
| 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
 | * Practical
* Oral
* Observation
* Written
 |
| 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
 | * Observation
* Written
* Oral
* Practical
 |
| 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
 | * Observation
* Written
* Oral
* Practical
 |
| 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
 | * Observation
* Written
* Oral
* Practical
 |

**Suggested Methods of Delivery**

* Presentations and practical demonstrations by trainer;
* Guided learner activities and research to develop underpinning knowledge;
* Supervised activities and projects in a workshop;

The delivery may also be supplemented and enhanced by the following, if the opportunity allows:

* Visiting lecturer/trainer from the motor vehicle service and repair sector;
* Industrial visits.

**Recommended Resources**

|  |
| --- |
| **Tools*** Comprehensive set of hand and power tools for industrial maintenance and repair.
* Electrical testing tools
* Specialist tools for specific electro-mechanical systems
 |
| **Equipment** * A fully equipped electro-mechanical parts store;
* Electrical testing equipment
* Lifts and ladders;
* Hoists and cranes
* Diagnostic equipment appropriate 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;
 |
| **Materials and supplies**Consumables for maintaining mechanical systems:* Oils and lubricants;
* Bearings
* Seals and gaskets
* Bolts
* Nuts
* Screws
* Thread tapes
* Washers

Consumables for maintaining electrical systems:* Cables and wiring
* Fuses
* Connectors
* Capacitors
* Batteries
* Resistors
* Diodes
* Shrink-wraps
* Electrical Insulating tapes

Replacement parts including: * Air, oil, exhaust, and air conditioning filters;
* Drive belts.
* Motors
* Chains
* Gears
* Rollers
* Bearings
 |
| **Reference materials**Manufacturers service manuals for electro-mechanical system being serviced;Appropriate electro-mechanical engineering text booksHealth and Safety manuals |

## MECHATRONIC SYSTEMS INSTRUMENTATION AND CONTROL

**UNIT CODE: ENG/CU/MC/CR/04/6/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **perform mechatronic systems instrumentation and control**

 **Duration of Unit: 120** hours

**Unit description**

This unit covers the competencies required to **perform mechatronic systems instrumentation and control**. It involves competencies to; observe occupational health and safety, design a control system, 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

 **Summary of Learning Outcomes**

1. Observe occupational health and safety
2. Design a control system
3. Document the control system design and specifications
4. Install mechatronic instrumentation and control system
5. Analyse instrumentation and control data
6. Service and/or repair mechatronic system

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Observe occupational health and safety
 | * + Types and usage of PPE
	+ Industrial safety signs
	+ Safety standards
	+ Safety operations
	+ First aid
	+ Fire fighting
	+ House keeping
 | * Practical
* Observation
* Written
* Oral
 |
| 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
* Oral
* Practical
 |
| 1. Document the control system design and specifications
 | * Developing of technical report
* Developing of operation and maintenance manual
* Patenting
 | * Practical
* Oral
* Observation
* Written
 |
| 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
* Observation
* Written
 |
| 1. Analyse instrumentation and control data
 | * Data selection
* Data collection and documentation
* Data analysis
 | • Practical• Oral• Observation• Written |
| 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• Observation• Written |

**Suggested Methods of Delivery**

* Presentations and practical demonstrations by trainer;
* Guided learner activities and research to develop underpinning knowledge;
* Supervised activities and projects in a workshop;

The delivery may also be supplemented and enhanced by the following, if the opportunity allows:

* Visiting lecturer/trainer from the mechatronics service and repair sector;
* Industrial visits.

**Recommended Resources**

|  |
| --- |
| **Tools**Comprehensive set of hand tools and power tools |
| **Equipment** * 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;
 |
| **Materials and supplies**Consumables for electrical installation* 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)
 |
| **Reference materials**Manufacturers service manuals for all the modulesAppropriate control and instrumentation engineering text books  |

## MECHATRONIC PROGRAMMING

**UNIT CODE: ENG/CU/MC/CR/05/6/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Carry out Mechatronic Programming**

**Duration of Unit: 140** hours

**Unit description**

This unit describes the competencies required by a technician in order to carry out mechatronic programming. It involves identifying mechatronic programming languages used in machines, developing and customizing a mechatronic program, testing and configuring a mechatronic program, interfacing a mechatronic program with system and maintain mechatronic program.

**Summary of Learning Outcomes**

1. Identify mechatronic programming languages used in machine
2. Develop and customize a mechatronic program
3. Interface mechatronic program with system
4. Test and configure mechatronic program
5. Maintain mechatronic program

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify mechatronic programming languages used in machine
 | * Introduction to programming
* Types of mechatronic programming languages
* Programmable system hardware
* Applications of mechatronic programming languages
* Programming storage systems
 | * Practical
* Observation
* Written
* Oral
 |
| 1. Develop and customize a mechatronic program
 | * Programming mechatronic systems
* Algorithmic problem solving
* Program design
* Inputs and outputs of peripheral devices
* Program debugging
* Programming models and sequential flow charts
* Assembly languages and programming
 | * Observation
* Written
* Oral
* Practical
 |
| 1. Interface mechatronic program with system
 | * + Mechatronic system software requirements
	+ Mechatronic hardware termination and programming
	+ Basic knowledge of device input output interfacing and communication
	+ Data communication principles and networking
	+ Computer integrated manufacturing
 | * Practical
* Oral
* Observation
* Written
 |
| 1. Test and configure mechatronic program
 | * + Tools and equipment for testing programmable mechatronic systems
	+ Software debugging
	+ Input and output manipulation using mechatronic software
	+ Signal conditioning
 | * Observation
* Written
* Oral
* Practical
 |
| 1. Maintain mechatronic program
 | * Program debugging and fault diagnosis
* Program storage and memory types
* Data protection
* Continuous program improvement
* Emerging technologies
 | * Observation
* Written
* Oral
* Practical
 |

**Suggested Methods of Delivery**

* Presentations and practical demonstrations by trainer;
* Guided learner activities and research to develop underpinning knowledge;
* Supervised activities and projects in a workshop;

The delivery may also be supplemented and enhanced by the following, if the opportunity allows:

* Visiting lecturer/trainer from the motor vehicle service and repair sector;
* Industrial visits.

**Recommended Resources**

|  |
| --- |
| **Tools*** Comprehensive set of hand tools for assembly and disassembly of programmable units.
* Electrical testing tools
 |
| **Equipment*** Computer
* Integrated circuits
* Mother boards
* Storage devices
* Communication cables
* Displays & projectors
* Programmable logic controllers
* Sensors
* Actuators
* Instruments
 |
| **Materials and supplies*** Mechatronic engineering software
 |
| **Reference materials**Manufacturers programming manuals;Appropriate programming text books |

## OPERATING MECHATRONIC SYSTEMS

**UNIT CODE: ENG/CU/MC/CR/06/6/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Operate mechatronic systems**

**Duration of Unit: 130** hours

**Unit description**

This unit covers the competencies required to operate mechatronic systems. It involves observing occupational health and safety, interpreting installation manuals, installing mechatronic systems, integrating mechatronic systems, testing and commissioning mechatronic system and servicing and maintaining mechatronic system faults

**Summary of Learning Outcomes**

1. Observe occupational health and safety
2. Interpret installation manuals
3. Install mechatronic systems
4. Integrate mechatronic systems
5. Test and Commission mechatronic system
6. Service and maintain mechatronic system faults

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Observe occupational health and safety
 | * + Types and usage of PPE
	+ Industrial safety signs
	+ Safety standards
	+ Safety operations
	+ First aid
	+ Fire fighting
	+ House keeping
 | * Practical
* Observation
* Written
* Oral
 |
| 1. Interpret installation manuals
 | * + Obtaining procedures Installation manuals
	+ Interpretation of installation Manuals
	+ Storage of manuals for future use and references
 | * Practical
* Observation
 |
| 1. Install mechatronic systems
 | * Planar and spatial mechanics
* Introduction to mechatronic
* Inspection of mechatronic system
* Assembly of mechatronic system components
* Interfacing of control systems to mechatronic and automated system
* System programming, debugging, testing and uploading
* Mechatronic system operations.
 | * Observation
* Written
* Oral
* Practical
 |
| 1. Integrate mechatronic systems
 | * Feasibility analysis
* System architecture development
* System integration techniques
* Calibration
* System configuration management
 | * Practical
* Oral
* Observation
* Written
 |
| 1. Test and Commission mechatronic system
 | * Testing tools and equipment
* Mechatronic system parameters
* Monitoring, evaluation and assessment of system performance
* System commissioning
* Human resource development
 | * Practical
* Oral
* Observation
* Written
 |
| 1. Service and maintain mechatronic system faults
 | * System Fault diagnosis
* Mechatronic system service and repair
* System service and maintenance reporting and documentation
* maintenance scheduling
 | * Practical
* Oral
* Observation
* Written
 |

**Suggested Methods of Delivery**

* Presentations and practical demonstrations by trainer;
* Guided learner activities and research to develop underpinning knowledge;
* Supervised activities and projects in a workshop;

The delivery may also be supplemented and enhanced by the following, if the opportunity allows:

* Visiting lecturer/trainer from the mechatronics service and repair sector;
* Industrial visits.

**Recommended Resources**

|  |
| --- |
| **Tools**Comprehensive set of hand tools and power tools |
| **Equipment** * 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
* Facilities for the disposal of waste oil and used parts;
 |
| **Materials and supplies**Consumables for electrical installation* 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
 |
| **Reference materials**Manufacturers service manuals for all the modulesAppropriate industrial automation and robotics engineering text books |

## MANAGING MECHATRONIC PROJECTS

**UNIT CODE:**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Manage Mechatronic Projects**

**Duration of Unit: 120** hours

**Unit description**

This unit describes the competencies required by a technician in order to manage mechatronic projects. It involves selecting and planning mechatronic project technology, coordinating activities for mechatronic projects, coordinating personnel for mechatronic projects, analyzing and documenting mechatronic project activities and managing quality control of mechatronic projects.

**Summary of Learning Outcomes**

1. Select and plan mechatronic project technology
2. Coordinate activities for mechatronic projects
3. Coordinate personnel for mechatronic projects
4. Analyze and documents mechatronic project activities
5. Manage quality control of mechatronic projects

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

|  |  |  |
| --- | --- | --- |
| **LEARNING OUTCOME** | **CONTENT** | **Suggested Assessment Methods** |
| 1. Select and plan mechatronic projects
 | * Principles and practices of management
* Project procurement technology
* Project technologies
* Project technical resources
* Risk analysis
* Consultation
* Identification of project phases
* Regulations in mechatronic projects
 | * Observation
* Written
* Oral
* Practical
 |
| 1. Coordinate activities for mechatronic projects
 | * Action plan development
* Work scheduling
* Tools, and equipment storage
* Material handling
* Time management
* Operations management
* Principles of monitoring and evaluation
 | * Observation
* Written
* Oral
* Practical
 |
| 1. Coordinate personnel for mechatronic projects
 | * + Human resource management
	+ Delegation of tasks and duties
	+ Staff appraisal
	+ Roster management
	+ Communication skills and technology
	+ Governance and ethics
 | * Practical
* Oral
* Observation
* Written
 |
| 1. Analyze and documents mechatronic project activities
 | * + Project analysis
	+ Project adjustments
	+ Record keeping
	+ Project reporting
	+ Project documentation
 | * Observation
* Written
* Oral
* Practical
 |
| 1. Manage quality control of mechatronic projects
 | * Project quality management
* Work quality assessment
* Quality standards
* Multi stage control points
 | * Observation
* Written
* Oral
* Practical
 |

**Suggested Methods of Delivery**

* Presentations and practical demonstrations by trainer;
* Guided learner activities and research to develop underpinning knowledge;
* Supervised activities and projects in a workshop;

The delivery may also be supplemented and enhanced by the following, if the opportunity allows:

* Visiting lecturer/trainer from the motor vehicle service and repair sector;
* Industrial visits.

**Recommended Resources**

|  |
| --- |
| **Tools*** Measurement and calibration tools
* Appropriate management software
	+ Gant charts
	+ Microsoft project
	+ Smart sheet
 |
| **Equipment*** Computers
* Projectors
* Workstation
 |
| **Materials and supplies*** Writing tools
 |
| **Reference materials**Manufacturer manuals;Appropriate project management text books |