

**REPUBLIC OF KENYA**

**COMPETENCY BASED CURRICULUM**

**FOR**

**INSTRUMENTATION AND CONTROL LEVEL 5**



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 programs.

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 Engineering sector’s growth and sustainable development.

**PRINCIPAL SECRETARY, VOCATIONAL AND TECHNICAL TRAINING**

**MINISTRY OF EDUCATION**

**PREFACE**

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

The Technical and Vocational Education and Training Act on Reforming Education and Training in Kenya emphasized the need to reform 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 labor force.

TVET Curriculum Development, Assessment and Certification Council (TVET CDACC), in conjunction with Instrumentation and control Sector Skills Advisory Committee (SSAC) 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.

This 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, Instrumentation and control SSAC, expert workers and all those who participated in the development of this curriculum.

**CHAIRPERSON, TVET CDACC**

# ACKNOWLEDGEMENT

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 recognize with appreciation the role of the Instrumentation and Control Sector Skills Advisory Committee (SSAC) in ensuring that competencies required by the industry are addressed in the curriculum. I also thank all stakeholders in Engineering 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 Engineering Sector acquire competencies that will enable them to perform their work more efficiently.

**CEO/COUNCIL SECRETARY**

**TVET CDACC**

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# ACRONYMNS AND ABBREVIATIONS

A Control Version

AC Alternate Current

AIDS Acquired Immunodeficiency Syndrome

BC Basic Competencies

CAD Computer Aided Design

CBET Competency Based Education and Training

CC Common Competencies

CDACC Curriculum Development, Assessment and Certification Council

CEO Council Secretary

CR Core Competencies

CRO Cathode Ray Oscilloscope

CU Curriculum

DCS Distributed Control System

DIAC Diode for Alternating Current

DP Differential Pressure

EHS Environment, Health and Safety

EMCA Environmental Management and Coordination Act

ENG Engineering

EPRA Energy and Petroleum Regulatory Authority

ET Electronics Technician

FETs Field Effect Transitor

HIV Human Immunodeficiency Virus

HMI Human-Machine Interface

IBMS Integrated Building Management System

IC Instrumentation and Control

IEE Institute of Electrical Engineers

KCSE Kenya Certificate of Secondary Education

KEBS Kenya Bureau of Standards

KNQA Kenya National Qualification Authority

KPLC Kenya Power and Lighting Company

LCD Liquid Crystal Display

LASCR Light Activated Silicon Controlled Rectifier

NCA National Construction Authority

NEMA National environment Management Authority

NPN Negative Positive Negative

OS Occupational Standards

OSHA Occupational Safety and Health Act

PESTEL Political Environmental Social Technological Economical Legal

PLC Programmable Logic Controller

PNP Positive Negative Positive

PPE Personal Protective Equipment

PVC Colloquial Polyvinyl Vinyl

TRIAC Triode for Alternating Current

UJT Unijunction Transistor

Q&A Questions and Answer

SCADA Supervisory Control and Data Acquisition

SCR Silicon Controlled Rectifier

SACs Simple Automation Control

SSAC Sector Skill Advisory Committee

SWOT Strength Weakness Opportunity Threat

TVET Technical and Vocational Education and Training

UV Ultra Violet

WIBA Work Injury Benefits Act

**KEY TO UNIT CODE**

ENG/CU/IC/BC/01/5/A

Industry or sector

Curriculum

Occupational area

Type of competency

Competency number

Competency level

Control Version

# OVERVIEW

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

The course consists of basic, common and core units of learning as indicated below:

**Basic Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Duration in Hours** | **Credit Factors** |
| ENG/CU/IC/BC/01/5/A | Communication Skills | 25 | 2.5 |
| ENG/CU/IC/BC/02/5/A | Digital Literacy | 45 | 4.5 |
| ENG/CU/IC/BC/03/5/A | Entrepreneurial Skills | 70 | 7 |
| ENG/CU/IC/BC/04/5/A | Employability Skills | 50 | 5 |
| ENG/CU/IC/BC/05/5/A | Environmental Literacy | 25 | 2.5 |
| ENG/CU/IC/BC/06/5/A | Occupational Safety and Health Practices | 25 | 2.5 |
| Subtotal 1 | | **240** | **24.0** |

**Common Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Duration in Hours** | **Credit Factors** |
| ENG/CU/IC/CC/02/5/A | Engineering Mathematics | 120 | 12 |
| ENG/CU/IC/CC/01/5/A | Electronics | 90 | 9 |
| ENG/CU/IC/CC/03/5/A | Workshop Technology | 90 | 9 |
| ENG/CU/IC/CC/04/5/A | Electrical Principles | 120 | 12 |
| ENG/CU/IC/CC/05/5/A | Technical Drawing | 70 | 7 |
| Subtotal 2 | | **490** | **49.0** |

**Core Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Duration in Hours** | **Credit Factors** |
| ENG/CU/IC/CR/01/5/A | Electrical Installation | 120 | 12 |
| ENG/CU/IC/CR/02/5/A | Control Systems | 120 | 12 |
| ENG/CU/IC/CR/03/5/A | Industrial Measurement and Instrumentation | 100 | 10 |
| ENG/CU/IC/CR/04/5/A | Instrumentation, Control and Transmission System Maintenance | 90 | 90 |
| ENG/CU/IC/CR/05/5/A | Transmission System | 120 | 120 |
| ENG/CU/IC/CR/05/5/A | Industrial Attachment | 360 | 36 |
| Subtotal 3 | | **910** | **91** |
| **Grand Total** | | **1,640** | **164.0** |

The total duration of the **course is 1,640** hours

**Entry Requirements**

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

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

**Or**

1. Level 4 certificate in Instrumentation and Control

**Or**

1. Equivalent qualifications as determined by Kenya National Qualifications Authority (KNQA)

**Trainer qualification**

The trainer for this course must have a qualification higher than these course

**Industrial attachment**

An individual enrolled in this course will be required to undergo an industrial attachment in an Instrumentation and Control firm for a period of at least 480 hours. Attachment will be undertaken upon completion of the course or the unit of learning.

**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.

**Certification**

A candidate will be issued with a Certificate of Competency on demonstration of competence in a unit of competency. To attain the qualification Instrumentation technician Level 5, the candidate must demonstrate competence in all the units of competency as given in qualification pack. These certificates will be issued by TVET CDACC in conjunction with training provider.

# BASIC UNITS OF LEARNING

# COMMUNICATION SKILLS

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

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Communication Skills

**Duration of Unit:** 25hours

**Unit Description**

This unit covers the competencies required to demonstrate communication skills. It involves meeting communication needs of clients and colleagues, contributing to the development of communication strategies, conducting workplace interviews, facilitating group discussions and representing the organisation.

**Summary of Learning Outcomes**

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

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

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

**Suggested Methods of Instruction**

* Role playing
* Viewing of related videos

**Recommended Resources**

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

# 

# DIGITAL LITERACY

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

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Digital Literacy

**Duration of Unit:** 45 hours

**Unit Description**

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

**Summary of Learning Outcomes**

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

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

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

**Suggested Methods of Instruction**

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

**Recommended Resources**

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

# ENTREPRENEURIAL SKILLS

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

Relationship to occupational standards

This unit addresses the Unit of Competency: demonstrate entrepreneurial skills

**Duration of unit:** 70 hours

**Unit Description**

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

**Summary of Learning Outcomes**

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

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

**Suggested Methods of Instruction:**

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

**Recommended Resources**

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

# EMPLOYABILITY SKILLS

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

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Employability Skills

**Duration of Unit:** 50 hours

**Unit Description**

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

**Summary of Learning Outcomes**

1. Conduct self-management

2. Demonstrate interpersonal communication

3. Demonstrate critical safe work habits

4. Lead small teams

5. Plan and organize work

6. Maintain professional growth and development

7. Demonstrate workplace learning

8. Demonstrate problem solving skills

9. Demonstrate workplace ethics

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

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

**Suggested Methods of Instruction**

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

**Recommended Resources**

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

# ENVIRONMENTAL LITERACY

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

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: demonstrate environmental literacy

**Duration of Unit:** 25 hours

**Unit Description**

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

**Summary of Learning Outcomes**

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

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

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

**Suggested Methods of Instruction**

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

**Recommended Resources**

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

# OCCUPATIONAL SAFETY AND HEALTH PRACTICES

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

**Relationship to Occupational Standards**

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

**Duration of Unit:** 25 hours

**Unit Description**

This unit specifies the competencies required to identify workplace hazards and risk, identify and implement appropriate control measures and implement OSH programs, procedures and policies/ guidelines

**Summary of Learning Outcomes**

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

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

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

**Suggested Methods of Instruction**

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

**Recommended Resources**

* Standard operating and/or other workplace procedures manuals
* Specific job procedures manuals
* Machine/equipment manufacturer’s specifications and instructions
* Personal Protective Equipment (PPE) e.g.
* Mask
* Face mask/shield
* Safety boots
* Safety harness
* Arm/Hand guard, gloves
* Eye protection (goggles, shield)
* Hearing protection (ear muffs, ear plugs)
* Hair Net/cap/bonnet
* Hard hat
* Face protection (mask, shield)
* Apron/Gown/coverall/jump suit
* Anti-static suits
* High-visibility reflective vest

# COMMON UNITS OF LEARNING

## ENGINEERING MATHEMATICS

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

**Relationship to Occupational Standards**

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

Duration of Unit: 90 hours

**Unit Description**

This unit describes the competencies required by a Mechatronics technician to apply a wide range of Engineering mathematics in their work. This includes; applying algebraic functions, applying trigonometry and hyperbolic functions, applying complex numbers, coordinate geometry, carrying out binomial expansion, calculus, statistics, vector theory, matrix and numerical methods in solving problems, probability, commercial calculations, performing estimations, measurements and calculation of quantities.

**Summary of Learning Outcomes**

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

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

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

**Suggested Methods of Instruction**

* 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.

# ELECTRONICS

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Demonstrate understanding of electronics

**Duration of Unit:** 90 hours

**Unit Description**

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

**Summary of Learning Outcomes**

* + 1. Apply semiconductor theory
    2. Apply semiconductor diodes
    3. Demonstrate understanding of transistors
    4. Apply special semiconductor devices
    5. Perform rectification
    6. Apply digital electronics

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply semiconductor theory | * Meaning of terms * Types of materials * Insulators * Conductors * Semiconductors * Semiconductor materials * Types of semiconductors materials * Intrinsic and Extrinsic | * Observation * Oral questioning * Written tests |
| 1. Apply semiconductor diodes | * Meaning of terms * P-N juction * Semiconductor diodes * Foreward and reverse Characteristics * Types of semicondctor diodes * Application of semiconductors diodes | * Written tests * Oral questioning |
| 1. Demonstrate understanding of transistors | * Bipolar junction transistors * Operation of NPN and PNP * Field effect transistors * Operation N and P channels * Types of FETs * BJTs and FETs biasing * BJTs and FETs configuration * Characteristics of transistors * Gain of transistors * DC/AC load lines | * Observation * Oral questioning * Written tests |
| 1. Apply special semiconductor devices | * Meaning of terms * Types of special semiconductor devices * UJT * SCR * LASCR * TRIAC * DIAC * SCS * Application of special semiconductor devices | * Observation * Oral questioning * Written tests |
| 1. Perform rectification | * Meaning of Terms * Classification of rectifiers * Types of rectifiers * Application of rectifiers | * Written tests * Oral questioning * Practical tests * Observation |
| 1. Apply digital electronics | * Meaning of terms * Numbers systems e.g. * Decimal * Octal * Hexadecimal * Binary * Number system representation * Conversion of number systems e.g. * Decimal to binary * Binary to decimal * Decimal to hexadecimal * Hexadecimal to decimal * Hexadecimal to binary * Binary to hexadecimal * ASCII conversions * Boolean algebra and arithmetics * Logic gates e.g. * AND * OR * NOR * NAND * Combination of logic circuits e.g. * XOR * XNOR * Flip flops * Application of Flip-Flops | * Written tests * Oral questioning * Practical tests * Observation |

**Suggested Methods of Instruction**

* Discussions
* Site visits
* On-job-training
* Charts and Audio-visual presentations

**Recommended Resources**

* Computers
* Printers
* Cameras
* Phones
* Manufacturers’ catalogues
* Working drawings
* EMCA Act
* OSHA
* County by-laws
* Stationery

# WORKSHOP TECHNOLOGY PROCESSES

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Perform workshop processes

**Duration of Unit:** 90 hours

**Unit Description**

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

**Summary of Learning Outcomes**

1. Apply workshop safety
2. Use of workshop tools, Instruments and equipment
3. Prepare workshop tools and instruments for an Electrical installation practical
4. Prepare the workshop for an Electrical practical
5. Store Electrical tools and materials after practical
6. Troubleshoot and repair workshop tools and equipment

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply workshop safety | * Meaning of PPE * Standard operating procedure in PPE * Workshop rules * Electrical hazards e.g. * Electric shock. * Fire * Classes of fire * Causes of fire * Various methods of fire extinguishing * First Aid | * Oral questioning * Written tests |
| 1. Use of workshop tools, Instruments and equipment | * Meaning of workshop tools, instruments and equipment * Uses of workshop tools, Instruments and equipment * Classification of workshop tools and equipment * Care and Maintenance of workshop tools and Instruments | * Oral questioning * Practical tests * Written tests |
| 1. Prepare workshop tools and instruments for an Electrical installation practical | * Tools and instruments for an Electrical practical * Preparation of a list of tools and instruments for an Electrical practical. * Issuing and confirmation of tools and instruments before and after practical * Testing of practical tools and Instruments | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Prepare workshop for an Electrical practical | * Practical stations * Interpretation of a list of practical material | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Store Electrical tools and materials after practical | * Classification of workshop tools and instruments. * Storage of workshop Tools and equipment * Waste disposal | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Troubleshoot and repair/replace workshop tools and equipment | * Meaning of troubleshooting * Common faults in Electrical equipment   + Fault diagnosis procedure * Repair/Replace of components in Electrical equipment | * Observation * Oral questioning * Practical tests * Written tests |

**Suggested Methods of Instruction**

* Demonstration by trainer
* Practice by the trainee
* Field trips
* On-job-training
* Discussions

**Recommended resources**

* Set of screw drivers
* Pliers
* Phase testers
* Multimeter
* Stationery
* Cables
* Lubricants
* Service parts
* PPE –hand gloves, dust coat, dust masks
* Multimeter
* Clamp meter
* Earth electrode resistance meter
* Phase sequence meter
* IEE regulations
* Organizational procedures manual

# ELECTRICAL PRINCIPLES

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: apply electrical principles

**Duration of Unit:** 120 hours

**Unit Description**

This unit specifies the competencies required to apply electrical principles. It involves using the concept of basic electrical quantities, using the concepts of D.C and A.C circuits in electrical installation, using basic electrical machine, demonstrating understanding of three phase power supply, using power factor in electrical installation, using earthing in electrical installations, applying lightning protection measures, applying electromagnetic field theory, applying electrodynamics, applying energy and momentum in electromagnetic field, applying transient in electrical circuit analysis, using two port network and demonstrating understanding of refrigeration and air conditioning.

**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. Demonstrate understanding of three phase power supply
5. Use of power factor in electrical installation
6. Use of earthing in electrical installations
7. Apply lightning protection measures
8. Apply Electromagnetic field theory
9. Apply Electrodynamics
10. Apply Energy and momentum in Electromagnetic field
11. Apply Transient in Electrical circuit analysis
12. Use two port networks
13. Demonstrate understanding of Refrigeration and Air conditioning

**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 * Ohm’s law * 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 * Supervised exercises |
| * + 1. Use the concepts of D.C and A.C circuits in electrical installation | * Meaning of terms * AC and DC, parallel and series circuits * AC and DC network theorems * AC to DC and DC to AC Conversion * Basic solar photovoltaic systems | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * + 1. Use of basic electrical machine | * Types of Electrical machines * DC machines, * AC Single and three phase motors, generators and Transformers * Motor starting methods e.g * DOL * Star-Delta * Auto-transformer * Resistance starter * Shaded pole * Split phase * Capacitor start * Capacitor Start and run * Face plate Starting * Application of AC and DC machines * Special machines and their Applications * Electric Drives | * Assignments * Oral questioning * Supervised exercises * Written tests * Practical tests |
| * + 1. Demonstrate understanding of three phase power supply | * Meaning of Terms * Three phase power supply connection * Star connection * Delta connection * Voltage, Current and power calculation * Measurements of power * Wattmeter methods * Interconnection of three phase power supply * Star- Delta and Delta- Star | * Assignments * Oral questioning * Practical tests * Observation * Written test |
| * + 1. Use of power factor in electrical installation | * Meaning of power factor * Meaning of terms * Power triangle * Power factor correction | * Assignments * Oral questioning * Practical tests * Observation * Supervised exercises * Written tests |
| * + 1. Use of earthing in Electrical installations | * + Terms in Earthing   + Earthing points in Electrical installation   + Methods of earthing   + Factors to consider in selecting an earthing method   + Testing an earthing system | * Assignments * Supervised exercises * Written tests * Practical test |
| * + 1. Apply lightening 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 * Supervised exercises * Written tests |
| * + 1. Apply Electromagnetic field Theory | * + Meaning of Electromagnetic Field Theory   + Sources of Electromagnetic Fields   + Detectors of Electromagnetic radiation   + Application of Electromagnetic waves   + Electromagnetics Laws * Faraday’s Law * Lenz’s law * Fleming’s Laws * Properties and Effects of Electromagnetic waves * Wave Characteristics and Shielding * Skin Effect | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * + 1. Apply Electrodynamics | * Meaning of Electrostatics * Identification of Electrostatic terms and their meaning * Meaning of terms in magnetostatics * Electrodynamics laws * Faraday’s law | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * + 1. Apply Energy and Momentum in Electromagnetic field | * + Energy conservation theorem: * Poyntings’ Theorem * Momentum Energy Flow * Electromagnetic Energy flow | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * + 1. Apply transients in Electrical Circuit Analysis | * + Meaning of Growth and decay in R-L & R-C circuits   + Calculations involving R-L& R-C circuits   + Application of Growth and decay in R-L & R-C Circuits | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * + 1. Use Two Port networks | * + Meaning of passive networks * Types of Passive network   + Characteristic impedance in T & pie networks   + Design of T & pie networks   + Transmission lines   + ABCD Constants   + Network in cascade | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * + 1. Demonstrate understanding of Refrigeration and Air conditioning | * Meaning of Refrigeration and Air Conditioning * Operation of Refrigeration and Air conditioning * Plant layout of Refrigeration and Air conditioning system | * Assignments * Oral questioning * Supervised exercises * Written tests |

**Suggested Methods of Instruction**

* 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

**TECHNICAL DRAWING**

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

**Relationship to Occupational Standards**

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

**Duration of Unit:** 70hours

**Unit Description**

This unit covers the competencies required to prepare and interpret technical drawings. It involves using and maintaining drawing equipment and materials, producing plane geometry drawings, producing solid geometry drawings, producing orthographic drawings, and producing pictorial drawings, producing electrical drawings and applying CAD packages **Summary of Learning Outcomes**

1. Use and maintain drawing equipment and materials
2. Produce plane geometry drawings
3. Produce solid geometry drawings
4. Produce orthographic drawings and produce pictorial drawings
5. Produce electrical drawings
6. Apply CAD packages

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Use and maintain drawing equipment and materials | * Identification and care of drawing equipment * Identification and care of drawing materials * Reference to manufacturer’s instructions and work place procedures on use and maintenance of drawing equipment and materials * Reference to relevant environmental legislations * Use of Personal Protective Equipment (PPEs) | * Observation * Oral questioning * Written tests |
| 1. Produce plane geometry drawings | * Types of lines in drawings * Construction of geometric forms e.g. squares, circles * Construction of different angles * Measurement of different angles * Bisection of different angles and lines * Standard drawing conventions | * Oral questioning * Practical tests * Observation |
| 1. Produce solid geometry drawings | * Interpretation of sketches and drawings of patterns e.g. cylinders, prisms and pyramids * Sectioning of solids e.g. prisms, cones * Development and interpenetrations of solids e.g. cylinder to cylinder and cylinder to triangular, prism | * Observation * Practical tests * Oral questioning |
| 1. Produce orthographic drawings and produce pictorial drawings | * Meaning of pictorial and orthographic drawings * Meaning of sectioning * Meaning of symbols and abbreviations * Drawing and interpretation of orthographic elevations * Dimensioning of orthographic elevations * Sectioning of views * Assembly drawing * Meaning of pictorial drawings * Drawing objects in isometric view * Drawing objects in oblique view | * Observation * Practical tests * Oral questioning |
| 1. Produce electrical drawings | * Electrical symbols and abbreviations * Meaning of electrical drawings * Drawing of electrical diagrams e.g. block, schematic, circuit, line and wiring | * Observation * Oral questioning * Practical tests |
| 1. Apply CAD packages | * Identification of CAD packages e.g. AutoCAD, circuit maker * Use of CAD packages in drawing of: * Plane geometry * Solid * Orthographic * Pictorial * Electrical e.g. block, schematic, circuit, line and wiring | * Observation * Oral questioning * Practical tests |

**Suggested Methods of Instruction**

* Projects
* Demonstration by trainer
* Practice by the trainee
* Discussions

**Recommended Resources**

* Drawing room
* Drawing instruments e.g. T-squares, set squares, drawing sets
* Drawing tables
* Pencils, papers, erasers
* Masking tapes
* Computers installed with relevant CAD packages

# CORE UNITS OF LEARNING

# ELECTRICAL INSTALLATION

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Perform Electrical Installation

**Duration of Unit:** 120 hours

**Unit Description**

This unit specifies competencies required for performing electrical installation. Competencies required includes; conducting site survey, performing system sizing, preparation of working drawings, preparation of list of tools equipment and materials, preparation of installation work plan, establishment of installation team, performing installation, terminating installation, inspecting, testing installation and commissioning the installation.

**Summary of Learning Outcomes**

1. Conduct site survey
2. Perform system sizing
3. Prepare working drawings
4. Prepare list of tools, equipment and materials
5. Prepare installation work plan
6. Establish installation team
7. Perform electrical installation
8. Terminate electrical installation
9. Inspect and test electrical installation
10. Prepare reports and commission the installation

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| * + - * 1. Conduct site survey | * Type of installations * Domestic installations * Industrial installations * Commercial installations * Type of building e.g. * Permanent building * Semi-permanent buildings * Solar installation systems * Utilities available * Water * Electricity * Communication * Installation conditions e.g. temperature, humidity * Taking measurements on site e.g. * Length e.g. conduits size * Total area * Temperature * Humidity * Preparation site survey report | * Written tests * Observation * Oral questioning * Practical tests |
| * + - * 1. Perform system sizing | * Introduction to standards * IEE regulations. * Kenya bureau of standards (KEBS) * British standards * KPLC by-laws * EBK regulations * EPRA * County by-laws * National Construction Authority (NCA ) * Reference to relevant IEE regulation tables * Solar daily load energy demand * Solar equipment, cables and accessories sizing * Load Estimation e.g. * Factor of simultaneity (Ks) * Factor of utilization (Ku) * Determining cable : * Types * Ratings * sizes * Insulation type * Protective devices * Types * Ratings * Reference to relevant regulations | * Written tests * Observation * Oral questioning * Practical tests |
| * + - * 1. Prepare working drawing | * Working drawings * Meaning of working drawings * Drawing of electrical diagrams * Block * Circuits * Schematic * Wiring * Line * Reading and Interpretation of architectural drawings * Reading and Interpretation of electrical drawings * Drawing tools and equipment e.g. * Drawing board * T- square * Use of Computer Aided Design (CAD) applications e.g. AutoCAD | * Observation * Oral questioning * Practical tests * Written tests |
| * + - * 1. Prepare list of tools, equipment and materials | * Identification of tools and materials e.g. * Cutting tools * Measuring tools * Measuring equipment * Cables and conductors * Crimping tools * Conduits * Trunking * Consumables * Types, application, care, maintenance and storage of: * Tools e.g. * Cable strippers * Pliers * Screw drivers * Hammers * Chisels * Allen keys * Electrician knives * Crimping tools * Bending springs * Steel tapes * Draw wires * Hack saws * Drills * Equipment e.g. * Stock and die * Vice * Materials e.g. * Cables * Fittings * Accessories * Assemble tools, equipment and materials * Inventory management | * Oral questioning * Written tests * Observation * Practical tests |
| * + - * 1. Prepare installation work plan | * Identification of scope of installation work * Identify installation team * Meaning of terms * Preparation of work schedules * Bar charts * Gantt charts * Critical path networks * Raise the necessary permit and licences * Permit to work * Types of permit e.g. Gate pass, Name tags * Sources and application procedures in acquiring the permits * Classes of EPRA licenses   C2, C1, B, A2, A1 | * Written tests * Oral questioning * Observation |
| * + - * 1. Establish installation team | * Team building * Team members familiarization * Collaboration * Tasks distribution * Communication protocol | * Written tests * Oral questioning * Observation * Practical test |
| * + - * 1. Perform electrical installation | * Meaning of terms * Single phase and three phase installation * Domestic Installation * Industrial Installation * Commercial Installation * Phase/load balancing * Cables and cable joints * Wiring systems and accessories * Meaning of terms * Types and applications e.g. * Conduits * Cable trays * Cable ducts * Trunkings * Types of wiring systems e.g. * Surface wiring * PVC/ TRS/ CTS * Conduit wiring * Cleat wiring * Wooden casing * Marking out, cutting, bending, threading, chiselling, trenching * Draw –in/Lay of cables routes * Cable Identification * Installation of final circuits * Lighting circuits * One way, two way, intermediate * Dimmer switches * Looping in methods at ceiling rose, joint boxes, switches * Power circuits * Radial circuits, ring circuits * Water heating circuits * Electric cooker circuits * Call and alarm circuits * Bell circuits * Components of bell circuits * Relays * Bell transformers * Battery * Intruder alarm circuits * Fire alarm circuits * Solar system components e.g. * Solar modules * Charge controllers * Inverter * Batteries * Parts of an earthing system * Earthing continuity * Conductor * Earthing lead * Earth electrode * Methods of earthing * Direct * Protective multiple earthing | * Written tests * Observation * Oral questioning * Practical test |
| * + - * 1. Terminate Electrical installation | * Meaning of Terms * Importance of termination * Types of cable joints * Married * Telegraph * Bell hanger’s * Cable labeling * Cable lugging * Tools used in cable termination e.g. * Crimping tool * Strip Knife | * Written tests * Oral questioning * Practical tests * Observation |
| * + - * 1. Test and inspect Electrical installation | * Meaning of terms * Types of tests e.g. * Earth continuity tests * Ring circuit test * Insulation tests * Short circuit tests * Open circuit test * Testing tools e.g. * Multimeter * Insulation tester * Ohmmeter * Importance of installation testing * IEE regulations | * Written tests * Observation * Oral questioning * Practical tests |
| * + - * 1. Commission and prepare installation reports | * Meaning of terms * User training * Preparation of system’s standard operating procedures and manuals * Issuing of completion certificates * Preparation of installation reports * Sharing and documentation of installation reports * Commissioning of installation system | * Written tests * Observation * Oral questioning * Practical tests |

**Suggested Methods of Instruction**

* Demonstration by trainer
* Practice by the trainee
* Field trips
* On-job-training
* Discussions

**Recommended Resources**

* Measuring tools
* Cutting tool
* Drawing tools
* Drilling tools
* Fastening tools
* Stationery
* Assorted Cables
* Assorted protective devices
* Pipes and trunkings
* Cable lugs
* Joints
* Accessories
* PPEs (Personal Protective Equipment)
* Measuring equipment
* • Communication equipment Reference materials
* Standards
* County by-laws
* Occupational Safety and Health Act (OSHA)
* National Environmental Management Authority ( NEMA) regulations
* National Construction Authority (NCA) regulations
* IEE
* Tables

# CONTROL SYSTEMS

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Install control system

**Duration of Unit:** 120 hours

**Unit Description**

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

**Summary of Learning Outcomes**

1. Prepare working drawings
2. Prepare a list of tools, equipment, and materials
3. Configure and mount control system components
4. Perform wiring of control system components
5. Terminate control system wiring
6. Test the installed control system
7. Commission the system and document installation report

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Prepare working drawings | * Working drawings * Meaning of working drawings * Drawing of electrical diagrams * Block * Circuits * Schematic * Wiring * Line * Reading and Interpretation of architectural drawings * Reading and Interpretation of electrical drawings * Drawing tools and equipment e.g. * Drawing board * T- square * Use of Computer Aided Design (CAD) applications e.g. AutoCAD | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Prepare a list of tools, equipment, and materials | * Meaning of terms * Identification of tools and materials e.g. * Cutting tools * Measuring tools * Measuring equipment * Cables and conductors * Crimping tool * Conduits * Trunking * Consumables e.g. * Cable strippers * Pliers * Screw drivers * Hammers * Chisels * Allen keys * Electrician knives * Crimping tools * Bending springs * Steel tapes * Draw wires * Hack saws * Drills * Equipment e.g. * Multimeters * Computer * Materials e.g. * Cables * Fittings * Accessories * Assemble tools, equipment and materials * Inventory management | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Configure and mount control system components | * Meaning of terms * Labelling control system components * Control system components eg * SACs * DCSs * PLCs * HMIs * SCADA * Types of enclosures eg * Auxiliary enclosures * Cases (electrical and electronics switch) enclosures * Circuit breaker * Control panels * Distribution boards * Pushbuttons * Switch * Power control * Rectifier circuits(single and three phase) * Uncontrolled * Half controlled * Fully controlled * DC line communication * Parallel capacitance * Resonant turn-off * Coupled pulse * Load communication * Choppers * Principle of operation * Control strategies * AC and DC circuits * Inverters * Single phase centre tapped * Single phase bridge * Three phase bridge * Cyclo-converter operation * Principle of operation * Single phase * Three phase * Blocked group operation * Circulating current mode * Speed control of dc motors * Variable armature voltage * Variable flux * Rheostatic control * Chopper control | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Perform wiring of control system components | * Meaning of terms * Control system components circuits * Cable sizes and ratings * Type of wiring systems eg * Surface wiring * Batten wiring * Conduit wiring * Cleat wiring * CTS or TRS or PVC sheath wiring * Concealed wiring * Types of cables e.g. * Armored cables * Twisted cables * Stranded cables * Shielded cables * Coaxial cables * IEE regulations | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Terminate control system wiring | * Meaning of terms * Factors determining type of termination * Voltage * Current * Overhead or underground * Outdoor or indoor * Type of connectors * Methods of wiring termination * Crimp connections * Soldered connections * Compression termination * Wire wrapping connection * Direct connection * Loop or eye connection * Cable joints * Types of cable joints * Straight through joint * Y and T type joint * Pot end joints * Indoor and outdoor * OSHA regulations * IEE regulations | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Test the installed control system | * Meaning of terms * Configuration of inputs and output * Test instruments * Visual inspection of the system * Types of tests on control system eg * Test for input supply * Short circuit tests * Open circuit tests * Control system test signals * Step * Velocity * Acceleration * Sinusoidal * Unity impulse * Dynamic responses for 1st and 2nd order systems * Response terms * Standard 2nd order equation * Response graphs * Derivation of 2nd order equation * Control system damping methods * Velocity feedback * Error rate * Viscous damping * Effects of damping ratio * Calculations of limiting values * Control system stability * Types of stability * Bounded input bounded output * Relative stability * Absolute stability * Routh’s stability criterion * Nyquist diagrams * Bode plot * Nichol’s chart * Root locus * Control system compensation * Need for system compensation * Compensating networks transfer functions * Compensation network * Lead * Lag * Lead-lag * Design of compensation networks * Safety during testing control system * IEE regulation * Use manufacturer’s manuals in testing system components * Test running the control system | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Commission the system and document installation report | * User training * Preparation of system’s standard operating procedures and manuals * Issuing of completion certificates * Preparation of installation reports * Sharing and documentation of installation reports * Commissioning of control system | * Observation * Oral questioning * Practical tests * Written tests |

**Suggested methods of instructions**

* Demonstration by trainer
* Practice by the trainee
* Field trips
* Discussions

**Recommended Resources**

* Electrical measuring instruments
* Tightening instruments
* Soldering instruments
* Computers
* Stationery
* PCBs
* Test Certificate
* Cables
* Manufacturers’ manuals
* Relevant catalogues
* IEE regulations
* OSHA regulations

INDUSTRIAL MEASUREMENT AND INSTRUMENTATION

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: perform industrial measurement and instrumentation

**Duration of Unit:** 100 hours

**Unit Description**

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

**Summary of Learning Outcomes**

1. Demonstrate understanding of measurements
2. Apply analogue instruments
3. Apply electromechanical instruments
4. Apply digital instruments
5. Measure electrical and physical quantities
6. Apply waveform in analysing instruments
7. Apply sensors and transducers
8. Calibrate instruments

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| * + - 1. Demonstrate understanding of measurements | * Meaning of terms * Units of measurements * SI units and symbols eg * Mechanical units * Electrical units * Measurement of electrical quantities * Equipment reliability * Design and development * Types of failures * Assessment, testing and inspection * Reliability analysis * Industrial measurements and variables * Conversions * Dimensions * Measurement of errors * Gross errors * Systemic errors * Absolute errors * Relative errors * Accuracy * Precision * Resolution * Sensitivity * Significant figures * Measurement techniques * Speed measurement * Types of speed measuring devices eg * Electrical tachometers * Mechanical tachometers * Principles of speed measurement eg * Range of device/span * Type of motion * Applications * Pressure measurements * Terms used in pressure measurement * Atmospheric pressure * Gauge pressure * Absolute pressure * Operating principles of pressure measuring instruments * Pressure sensitive devices e.g. * U-tube and well type manometer * Barometer * Pneumatic pressure measuring instruments * Bourdon tube gauge * Bellows gauge * Metal and limp diaphragm * Piezo electric elements stain gauge * Protection of pressure measuring instruments insulation * Over range pressure * Viscous or solidifying liquids * Level measurement * Direct level methods e.g. * Sight glass * Displacer * Floats * Conductive probes * Capacitive probes * Ultrasonic * Indirect level methods * Radiation methods * Resistive method * Paddal wheels * Principle of operation of level measuring instrumentation * Sight glass * Ball float * Chain float * Conductivity probe * Differential pressure (DP) * Temperature measuring methods * Expunction of a material * Electrical system change * Semi-conductor characteristic change * Voltage generated by dissimilar metals * Radiated energy * Operating principle of temperature measuring instruments * Thermometers * Pressure spring thermometer * Bimetallic thermometer * Thermistor * Thermal couples * Measurement of viscosity, humidity and moisture * Principle of viscosity measurement * Viscosity terms * Viscosity meters * Principle of humidity and moisture measurement * Terms used in humidity measurement * Humidity meters * Types * Terms used in moisture measurement * Methods of moisture measurement * Pneumatic measurement systems * Types of differential pressure transmitters * torque balance * force balance * principle of pneumatic differential pressure transmitters * torque balance type * motion balance type * booster relay * electromagnetic differential pressure transmitters * Applications of differential pneumatic transmitter * Measurement of liquid level * Measurement of liquid flow * Measurement of temperature * Measurement of pressur * Functions of instruments * Indicating instruments * Recording instruments * Controlling instruments | * Written tests * Observation * Oral questioning |
| * + - 1. Apply analogue instruments | * Meaning of terms * Analogue Instruments * Voltmeter * Transistor voltmeter circuit * Voltmeter range changing * Difference amplifier voltmeter * Op amp amplifier Voltmeter * Voltage to current converter * Ohmeter * Series ohmmeter circuit * Shunt ohmmeter circuit * Linear ohmmeter * Ammeter * Ammeter circuit * Analogue electronic millimeter * Multimeter probes * High voltage probes * High current probes * Radio Frequency Probes * Calculation of errors * Statistical methods of analyzing errors * Arithmetic mean value * Deviation * Standard deviation * Performance characteristics * Static and dynamic characteristics e.g. * Accuracy * Repeatability * Stability * Constancy * Precision * Resolution * Errors and loading effects * Need for impedance matching * Maximum voltage, maximum power transfer * Buffer amplifiers * Errors calculations * Signal conditioning * Need of signal conditioning * Operation of signal conditioning elements * Bridges * Amplifiers * Modulators * Filters * Oscillators * Attenuators * Linearizers * Methods of signal conditioning * Amplifying * Attenuating * Modulating * Filtering * Scaling * Signal processing * Need for signal processing * Signal processing methods * Frequency to voltage and vice-versa * Analogue to digital and vice-versa * Data logging and data acquisition systems * Data presentation * Operation of display element * Oscilloscope * Nixing tube * Liquid crystal display (LCD) * Light emitting diode * Visual display unit * Operation of recording elements * X-Y recorder * Strip chart recorder * Magnetic tape recorder * Ultra violet (UV) * Oscillographic recorder * Galvanometric recorder * Pen recorder | * Observation * Oral questioning * Practical tests * Written tests |
| * + - 1. Apply electromechanical instruments | * Meaning of terms * Permanent magnet moving coil and moving iron instruments * Deflection instrument fundamentals * PMC construction * Torque equation and scale * Deflecting torque * Controlling torque * Damping torque * Galvanometer * Function * DC and AC galvanometer * Sensitivity * Use of a galvanometer as null meter of null detector * Types of galvanometers * Ballistic galvanometer * Vibration galvanometer * DC and AC Ammeters and Voltmeters * Ammeter circuit * Shunt resistance * Swamping resistance * Ammeter scale * Multirange ammeters * Rectifier ammeter * Voltmeter circuit * Swamping resistance * Multirange voltmeter * Rectifier voltmeter * Classifications * Moving iron type * Attraction type * Repulsion type * Moving coil type * DC permanent magnet type * Electrodynamic (dynamometer) type * Hot wire type * AC induction type * Split type * Shaded pole * Electrostatic type voltmeter * Wattmeter * Types of wattmeter * Dynamometer type * AC Induction type * DC Electrostatic type * Energy meters | * Observation * Oral questioning * Practical tests * Written tests |
| * + - 1. Apply digital instruments | * Meaning of terms * Logic gates circuits e.g. * AND gates * OR gates * NAND gates * Flipflops circuits * Digital displays e.g. * Light emitting diode displays * Liquid crystal displays * Digital counting e.g. * Scale-of-16 bit counter * Decade counter * Scale-of-2000 bit counter * Digital frequency division * Seven-segment display * Digital voltmeter * Digital multimeter * Digital Cathode ray oscilloscope * Analogue-to-digital converters * Methods of analogue to digital conversion * Digital-to-analogue converters * Methods of digital to analogue conversion * Calculations involving accuracy and resolution in digital instruments | * Observation * Oral questioning * Practical tests * Written tests |
| * + - 1. Measure electrical and physical quantities | * Meaning of terms * Methods resistance measurements * Voltmeter and ammeter methods * Substitution method * Wheatstone bridge * Low resistance measurement * Kelvin bridge * Four terminal resistors * Low resistance linear Ohmmeter * Micro-ohmmeter * High resistance measurements * Voltmeter and ammeter methods * Guard wire and guard ring * Wheatstone bridge measurement of high resistance * Hand-cranked megohmmeter * Measurement of inductance and capacitance * RC and RL equivalent circuits * Inductor and capacitor equivalent circuit * Q factor of an inductor * D factor of a capacitor * AC bridge theory * Circuit and balance equations * Capacitance bridges * Inductance bridges * Multifunction impedance bridge * Analogue and digital R-C-L meter * Measurement of physical quantities e.g. * Temperature * Humidity * Noise * Vibration * Dust | * Observation * Oral questioning * Practical tests * Written tests |
| * + - 1. Apply waveform analyzing instruments | * Meaning of terms * Cathode ray tube * Parts of a cathode ray tube * Cathode ray oscilloscope * Operation of a CRO * Classifications of CROs * Triggered sweep type * Recurrent sweep type * Dual trace, dual beam, sampling, digital readout CROs * Oscilloscope controls * Application of CROs | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Apply sensors and transducers | * Meaning of terms * Sensors * Transducers * Types of sensors and transducers e.g. * Resistance type * Inductance type * Capacitance type * Classification of transducers * Active transducers * Passive transducers * Signal processing * Analogue signal processing * Continuous time signal processing * Discrete time signal processing * Digital signal processing * Nonlinear signal processing * Statistical signal processing * Applications of signal processing * Data presentation displays * LED displays * LCD displays | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Calibrate instruments | * Meaning of calibration * Comparison methods * DC voltmeter calibration * DC ammeter calibration * Ohmmeter calibration * Wattmeter calibration * Digital multimeters as standard instruments * Calibration instruments * Precision voltage source * Voltage calibrator * Potentiometers * Basic potentiometers * Potentiometers with switched resistors * Potentiometer calibration methods * DC ammeter calibration * DC voltage calibration | * Observation * Oral questioning * Practical tests * Written tests |

**Suggested Methods of Instruction**

* Projects
* Demonstration by trainer
* Practice by the trainee
* Field trips
* On-job training
* Discussions

**Recommended Resources**

* Ammeters
* Voltmeters
* Ammeters
* Wattmeters
* Oscilloscope
* Electrician knives
* Calibrating instruments
* PPE – hand gloves, dust coats, dust masks, helmets, ear muffs, industrial boots
* Stationery
* Cables
* Computers
* Drawing instruments
* Cables
* IEE regulations
* Occupational safety and health act (OSHA)
* Work injury benefits act(WIBA)
* Manufacturers’ catalogues
* British standards
* KEBS standards

# INSTRUMENTATION, CONTROL AND TRANSMISSION SYSTEMS MAINTENANCE

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: maintain instrumentation, control and transmission systems

**Duration of Unit:** 90 hours

**Unit Description**

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

**Summary of Learning Outcomes**

* + 1. Prepare maintenance schedule
    2. Inspect and test instrumentation, control and transmission systems
    3. Prepare a list of maintenance tools, equipment and materials
    4. Perform maintenance activities
    5. Conduct system tests
    6. Document maintenance records

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| * + - 1. Prepare maintenance schedule | * Meaning of term * Maintenance checklist * Maintenance work plan * Identification of maintenance personnel * Types of maintenance and procedures e.g. * Periodic service * Preventive * Breakdown * Corrective * Planned * Scheduling maintenance based on service manuals | * Observation * Oral questioning * Written tests |
| * 1. Inspect and test instrumentation, control, and transmission systems | * Meaning of terms * Instrumentation components * Control system components * Transmission system comnponents * Hazard isolations * Types of fault * Short circuit faults * Open circuit faults * Grounding faults * Sysmmetrical and unsymmetrical faults * Identification of faulty components * System isolation points e.g. * Circuit breakers * Fuses * Isolators * Couplers * Fittings * Identification of maintenance activities * Types of tests * Troubleshooting procedure in systems * Recording test findings | * Written tests * Observation * Oral questioning * Practical tests |
| 3.Prepare a list of maintenance tools, equipment, and materials | * Identification and documentation of maintenance tools * Specifications of identified maintenance tools * Classification of maintenance tools e.g. * Fastening tools * Measuring tools * Cutting tools * Calibration of tools * Soldering tools e.g. * Soldering guns * Soldering irons * Resistance soldering sets * Pencil iron * Solder sucker * Electrostatic wrist strap * Soldering materials eg * Solder wire * PCBs * Labels and tags * Cable ties * Stick glue * Cables | * Written tests * Observation * Oral questioning * Practical tests |
| 4. Perform maintenance activities | * Identification faulty components * Repair/Replacement of faulty components * Maintenance activities e.g. * Diagnose the systems through; * Hardware rendudancy * Limit checking * Voting techniques * Special hardware * Artificail neural networks * Clustering * Pattern recognition * Disassembling * Cleaning * Tightening * Soldering * Assembling * Setting system parameters * Fill in maintenance checklist * Disposal of waste materials e.g. * Old batteries * Lugs and screws * Tapes * Cable sheaths * PCBs * Off cuts * Oils * Valves * Grease * Tubes * Ducts * Fittings * EHS regulations * OSHA regulations | * Written tests * Observation * Oral questioning * Practical tests |
| 5. Conduct system tests | * Visual inspection * Identification of test points * Types of tests eg * Continuity tests * Transmitter tests * Receiver tests * Output power * Power spectral density * Frequency stability * Leak tests * Pressure tests * Temperature tests * Test running the system * Safe test procedures * Recording of test results * IEE regulations | * Written tests * Observation * Oral questioning * Practical tests |
| 6. Document maintenance records | * Maintenance report writing * Procedure of writing maintenance report * Components of maintenance report * Checklist documentation * Test results documentation * Maintenance report documentation | * Written tests * Oral questioning |

**Suggested Methods of Instruction**

* Demonstration by trainer
* Practice by the trainee
* Field trips
* On-job-training
* Discussions

**Recommended Resources**

* Set of screw drivers
* Set of spanners and wrenches
* Power tools
* Cutting tools
* Pliers
* Lifting and tensioning tools
* Tool box
* Phase tester
* Stationery
* Cables
* PCBs
* Service parts
* PPE –hand gloves, dust coat, dust masks
* Multimeter
* Clamp meter
* Earth electrode resistance meter
* Phase sequence meter
* Service manuals
* IEE regulations
* Organization procedures manual
* EHS regulations
* OSHA regulations

# TRANSMISSION SYSTEMS

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Install transmission systems

**Duration of Unit:** 120 hours

**Unit Description**

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

**Summary of Learning Outcomes**

* + 1. Prepare working drawings
    2. Prepare a list of tools, equipment, and materials
    3. Mount transmission system components
    4. Perform wiring, tubing, and fitting of transmission system components
    5. Test the installed transmission system
    6. Commission the system and document installation report.

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Prepare working drawings | * Working drawings * Meaning of working drawings * Drawing of electrical diagrams * Block * Circuits * Schematic * Wiring * Line * Reading and Interpretation of architectural drawings * Reading and Interpretation of electrical drawings * Drawing tools and equipment e.g. * Drawing board * T- square * Use of Computer Aided Design (CAD) applications e.g. AutoCAD | * Written tests * Observation * Oral questioning * Practical tests |
| 1. Prepare a list of tools, equipment, and materials | * Meaning of terms * Identification of tools and materials e.g. * Cutting tools * Measuring tools * Measuring equipment * Cables and conductors * Crimping tool * Conduits * Trucking * Consumables eg * Cable strippers * Pliers * Screw drivers * Hammers * Chisels * Allen keys * Electrician knives * Crimping tools * Bending springs * Steel tapes * Draw wires * Hack saws * Drills * Equipment e.g. * Multimeters * Computer * Materials e.g. * Cables * Fittings * Tubes * Accessories * Thread seal * Assemble tools, equipment and materials * Inventory management | * Observation * Oral questioning * Written tests |
| * 1. Mount transmission system components | * Meaning of terms * Components of pneumatic systems e. g * Air compressor * Classification of air compressors * Positive displacement compressors * Dynamic compressors * Types of air compressors * Rotary screw * Reciprocating * Axial * Centrifugal * Piston compressors * Diaphragm compressors * Air drier * Types of air driers * Deliquescent * Regenerative desiccant * Refrigeration * Membrane * Air source treatment * Air filters * Air regulator * Air lubricator * Air valves * Types of air valves eg * Spring offset * Four way directional * Three way directional * Two way directional * Air cylinder * Single acting cylinders * Double acting cylinders * Air actuator * Types of pneumatic actuators eg * Tie rod cylinders * Rotary actuators * Rodless actuators * Grippers actuators * Vacuum generators * Components of a hydraulic transmission system eg * Hydraulic pump * Types of hydraulic pumps eg * Gear pumps * Rotary vane pumps * Screw pumps * Bent axis pumps * In line axial piston * Hydraulic control valve * Types of hydraulic control valves * Directional control * Pressure control * Flow control * Hydraulic actuator * Classification of hydraulic actuators * Linear actuators * Rotary actuators * Types of hydraulic actuators eg * Hydraulic helical valve * Electro-Hydraulic operator * Das hydraulic actuators * Subsea * Hydraulic cylinder * Components of a hydraulic cylinder eg * Hydraulic cylinder barrel * Hydraulic cylinder head * Hydraulic cylinder piston * Hydraulic cylinder rod * Cylinder seals * Self-locking nut * Spring ring * Cylinder flange * Bushes * Hydraulic motor * Types of hydraulic motors * Vane motors * Gear motors * Gerotor motors * Axial plunger motor * Radial piston motor * Hydraulic fluid reservoirs * Types of hydraulic fluid reservoirs eg * Vented reservoir * Pressurised reservoir * Electromechanical components eg * Electric motors * Solenoids * Components of electrical transmission system * Industrial networks * Types of networks eg * Local area networks * Wide area networks * Network wiring * Category 5 (CAT 5) * Category 6 (CAT 6) * Fibre optic cable * Co-axial cable * Twisted pair * Methods of data transmission * Half duplex * Full duplex * Network devices * Encoders * Decoders * Filters * Terminal reflectors * Attenuators * Signal amplifiers * Electromechanical components e.g. * Relay * Reed relay * Motor * Mounting of other transmission system components eg * Sensors * Transmitters * Fittings * Pressure gauges * Tubing | * Observation * Oral questioning * Written tests |
| * 1. Perform wiring, tubing, and fitting of transmission system components | * Meaning of terms * Motor control circuits * Motor starters * Interlocking * Cable sizes and ratings * Type of wiring systems * Surface wiring * Batten wiring * Conduit wiring * Concealed wiring * Types of cables e.g. * Armored cables * Twisted cables * Stranded cables * Shielded cables * Coaxial cables * IEE regulations * Tubing in transmission system * Classification of tubing * Structural tubing * Mechanical tubing * Pressure tubing * Fittings in transmission systems * Types of fittings eg * Elbows * Tees * Wyes * Crosses * Coupling * Unions * Compression * Caps * Plugs * Valves | * Written tests * Observation * Oral questioning * Practical tests |
| * 1. Test the installed transmission system | * Meaning of terms * Configuration of inputs and output * Test instruments * Visual inspection of the system * Classification of transmission system tests * Types of tests on transmission system eg * Test for input supply * Short circuit tests * Open circuit tests * Leak tests * Pressure tests * Temperature tests * Vibration tests * Safety during testing of a transmission system * IEE regulation * Use of manufacturer’s manuals during testing of system components * Test running the transmission system | * Written tests * Oral questioning |
| * 1. Commission the system and document installation report | * User training * Preparation of system’s standard operating procedures and manuals * Issuing of completion certificates * Preparation of installation reports * Sharing and documentation of installation reports * Commissioning of control system | * Written tests * Observation * Oral questioning * Practical tests |

**Suggested Methods of Instruction**

* Demonstration by trainer
* Practice by the trainee
* Field trips
* Discussions

**Recommended Resources**

* Installation instruments
* Electrical measuring instruments
* Tightening instruments
* Soldering instruments
* Computers
* Manufacturers’ manuals
* Relevant catalogues
* IEE regulations
* OSHA regulations