

**THE REPUBLIC OF KENYA**

**COMPETENCY BASED CURRICULUM**

**FOR**

**IRRIGATION AND DRAINAGE ENGINEERING TECHNOLOGY**

**LEVEL 6**

|  |  |
| --- | --- |
|  |  |
| **KENYA WATER INSTITUTE**  **P.O. BOX 60013-00200**  **NAIROBI** | **TVET CDACC**  **P.O. BOX 15745-00100**  **NAIROBI** |

First published 2019

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# FOREWORD

The provision of quality education and training is fundamental to the Government’s overall strategy for social economic development. Quality education and training will contribute to achievement of Kenya’s development 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. The policy document requires that training in TVET shall be competency based, curriculum development shall be industry led, certification shall be based on demonstration of competence and mode of delivery shall allow for multiple entry and exit in TVET programmes.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is important to note that the water sector has undergone numerous reforms in the last decade that require new approach to training of personnel for the sector. It is against this background that this curriculum for Irrigation and Drainage Engineering Technology has been developed to offer the required competency.

It is my conviction that this curriculum will play a great role towards development of competent human resource for the Water sector’s growth and sustainable development.

**PRINCIPAL SECRETARY**

**MINISTRY OF WATER & SANITATION AND IRRIGATION**

# PREFACE

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

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

Kenya Water Institute in conjunction with Water Sector Skills Advisory Committee (SSAC), National Irrigation Board (NIB), Jomo Kenyatta University of Agriculture and Technology (JKUAT) and University of Nairobi (UON) with guidance from TVET Curriculum Development, Assessment and Certification Council (TVET CDACC) has developed this curriculum.

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

I am grateful to the KEWI Academic Board, Technical Teams, TVET CDACC, and drawn from Universities and Water Sector Institutions, and all other stakeholders who participated in the development of this curriculum.

**CHAIRPERSON**

**KENYA WATER INSTITUTE GOVERNING COUNCIL**

# 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 SSAC in ensuring that competencies required by the industry are addressed in this curriculum. I also thank all experts in Academia and stakeholders in the Water sector for their valuable input and all those who participated in the process of developing this curriculum.

My gratitude also goes to Kenya Water Institute, TVET CDACC, National Irrigation Board and Experts from key water sector and allied institutions in the development of this curriculum.

I am convinced that this curriculum will go a long way in ensuring that workers in the water sector in general, and irrigated agriculture in particular will acquire relevant competencies that will enable them to perform their work more efficiently.

**CEO/COUNCIL SECRETARY**

**TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION COUNCIL**

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# ACRONYMS

|  |  |
| --- | --- |
| AC | Alternating Current |
| ADCP | Acoustic Doppler Current Profiler |
| ADP | Acoustic Doppler Profiler |
| ADV | Acoustic Doppler Velocimeter |
| AP | Arithmetic Progression |
| BOD | Biological Oxygen Demand |
| CAD | Computer Aided Design |
| CBC | Competence Based Curriculum |
| CBET | Competence Based Education and Training |
| CDACC | Curriculum Development, Assessment and Certification Council |
| COD | Chemical Oxygen Demand |
| CoK | Constitution of Kenya |
| CV | Curriculum Vitae |
| DC | Direct Current |
| DO | Dissolved oxygen |
| DI | Ductile Iron |
| DTP | Desktop Publishing |
| DWRTM | Diploma Water Resources Technology and Management |
| EMCA | Environmental Management Coordination Act |
| EMS | Environmental Management Systems |
| FAO | Food and Agriculture Organization |
| GHS | Globally Harmonized System |
| GI | Galvanized Iron |
| GIS | Geographical Information Systems |
| GP | Geometric Progression |
| GPS | Global Positioning System |
| ICT | Information Communication Technology |
| IEE | Institute of Electrical Engineers |
| ISO | International Standardization organization |
| IWRM | Integrated Water Resources Management |
| KCSE | Kenya Certificate of Secondary Education |
| KEBS | Kenya Bureau of Standards |
| KEWI | Kenya Water Institute |
| KNQA | Kenya National Qualifications Authority |
| KNQF | Kenya National Qualifications Framework |
| LCD | Liquid Crystal Display |
| NEMA | National Environmental Management Authority |
| OS | Operating Systems |
| OSH | Occupational Safety and Health |
| PC | Personal Computer |
| PE | Polyethylene |
| PPE | Personal Protective Equipment |
| PPR | Polypropylene |
| PV | Photovoltaic |
| PVC | Poly-vinyl-chloride |
| QGIS | Quantum Geographic Information Systems |
| RC | Reinforced Concatenate |
| R-L-C | Resistor-Inductor (L) - Circuit |
| SD | Standard Deviation |
| SDG | Sustainable Development Goals |
| SMART | Specific, Measurable, Achievable, Results-focused, time-bound |
| SSAC | Sector Skills Advisory Committee |
| SWOT | Strengths Weaknesses Opportunities and Threats |
| TV | Television |
| TVET | Technical Vocational Education and Training |
| TVETA | Technical Vocational Education and Training Authority |
| UV-VIS | Ultraviolet Visible |
| WRA | Water Resources Authority |
| WASPA | Water Service Providers Association |
| WASREB | Water Services Regulatory Board |
| WHO | World Health Organization |
| WHSA | Water Harvesting Storage Authority |
| WRA | Water Resources Authority |
| WRUA | Water Resources Users Association |
| WSP | Water Service Providers |
| WSTF | Water Services Trust Fund |

**KEY TO UNIT CODE**

**WAT/ OS/ IDET/ CC/01/ 6/A**

Industry or sector

Occupational Standards

Occupational area

Type of Unit

Unit number

Competency level

Version control

# COURSE OVERVIEW

Irrigation and Drainage Engineering Technology Level 6 qualification consists of competencies that an individual must achieve to enable him/her provide Irrigation and Drainage Engineering services. It involves designing, constructing irrigation and drainage infrastructure and operating and maintaining irrigation and drainage systems.

The units of learning comprising Irrigation and Drainage Engineering Technology Level 6 qualification include the following:

**Basic Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | Duration in Hours | Credit Factor |
| WAT/CU/IDET/BC/01/6A | Communication Skills | 45 | 4.5 |
| WAT/CU/IDET/BC/02/6A | Digital Literacy | 60 | 6.0 |
| WAT/CU/IDET/BC/03/6A | Entrepreneurial Skills | 90 | 9.0 |
| WAT/CU/IDET/BC/04/6A | Employability Skills | 45 | 4.5 |
| WAT/CU/IDET/BC/05/6A | Environmental Literacy | 90 | 9.0 |
| WAT/CU/IDET/BC/06/6A | Occupational Safety and Health Practices | 30 | 3.0 |
| **Total** | | **360** | **36.0** |

**Common Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Duration in Hours** | **Credit Factor** |
| WAT/CU/IDET/CC/01/6A | Water Quality Principles | 60 | 6.0 |
| WAT/CU/IDET/CC/02/6A | Physics Principles | 90 | 9.0 |
| WAT/CU/IDET/CC/03/6A | Engineering Mathematics | 150 | 15.0 |
| WAT/CU/IDET/CC/04/6A | Electrical and Mechanical Techniques | 60 | 6.0 |
| WAT/CU/IDET/CC/05/6A | Workshop Technology | 210 | 21.0 |
| WAT/CU/IDET/CC/06/6A | Technical Drawing and Computer Aided Drawing | 210 | 21.0 |
| WAT/CU/IDET/CC/07/6A | Water Technology Principles | 90 | 9.0 |
| WAT/CU/IDET/CC/08/6A | Soil and Crop Science | 120 | 12.0 |
| WAT/CU/IDET/CC/09/6A | Water Resources Management Principles | 60 | 6.0 |
| WAT/CU/IDET/CC/10/6A | Principles of Fluid Mechanics | 60 | 6.0 |
| WAT/CU/IDET/CC/11/6A | Principles of Soil Mechanics | 60 | 6.0 |
| WAT/CU/IDET/CC/12/6A | Principles of Structural Mechanics | 60 | 6.0 |
| **Total** | | **1230** | **123.0** |

**Core Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| Unit Code | Unit Title | Duration in Hours | Credit Factor |
| WAT/CU/IDET/CR/01/6A | Design of Irrigation and Drainage Infrastructure | 630 | 63.0 |
| WAT/CU/IDET/CR/02/6A | Construction of Irrigation and Drainage Infrastructure | 315 | 31.5 |
| WAT/CU/IDET/CR/03/6A | Irrigation and Drainage Systems Operation and Maintenance | 135 | 13.5 |
|  | Industrial attachment | 480 | 48.0 |
| **Total** | | **1560** | **156.0** |

|  |  |  |
| --- | --- | --- |
| **Grand Total** | **3150** | **315.0** |

**Entry Requirements**

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

1. Kenya Certificate of Secondary Education (KCSE) mean grade C- (minus)

**Or**

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

**Assessment**

The course will be assessed at two levels:

1. **Internal assessment**: conducted continuously by the trainer (internal assessor) who is monitored by an accredited internal verifier.
2. **External assessment:** conducted by an accredited external assessor who is monitored by an accredited external verifier.

The assessors and verifiers are registered by TVET CDACC which also coordinates external assessment.

**Certification**

An individual will be awarded a Certificate of Competency on demonstration of competence in a unit of competency. To be awarded Irrigation and Drainage Engineering Technology Certificate Level 6, an individual must demonstrate competence in all the units of competency in the qualification pack.

This certificate will be awarded by Kenya Water Institute.

# BASIC UNITS OF LEARNING

## COMMUNICATION SKILLS

**UNIT CODE:** WAT/CU/IDET/BC/01/6A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **demonstrate communication skills**

**Duration of Unit:** 45 Hours

**Unit Description**

This unit covers the competencies required demonstrate communication skills. It involves establishing communication needs of clients, developing communication strategies, establishing communication channels, conducting interviews, meetings and presentations. It also involves managing conflict in an organization.

**Summary of Learning Outcomes**

1. Establish communication needs of clients
2. Develop communication strategies
3. Establish communication channels

Conduct interviews

1. Conduct meetings
2. Conduct presentations
3. Manage conflict in an organization

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Establish communication needs of clients | * Communication process * Modes of communication * Medium of communication * Principles of effective communication * Barriers to communication * Vertical, horizontal and diagonal flow of communication * Communication skills * Forms of Communication * Cultural diversity and communication * Effective questioning techniques * Workplace etiquette | * Observation * Oral questioning * Written tests * Third party reports |
| 1. Develop communication strategies | * Effective communication strategies * Effective communication techniques * Types of target audience | * Observation * Oral questioning * Written tests * Third party reports |
| 1. Establish communication channels | * Face to face * Broadcast media * Electronic channels * Written channels | * Observation * Oral questioning * Written tests * Third party reports |
| 1. Conduct interview | * Structured and unstructured forms of interview * Types of interview * Principles of effective interview * Interview techniques * Interview process * Guidelines to effective interviewing * Guideline to interviewer * Guideline to interviewee * Preparation of interview reports | * Observation * Oral questioning * Written tests * Third party reports |
| 1. Conduct meetings | * Definitions * Structured and unstructured meetings * Types of meeting and procedures * Rules that govern the conduct of meetings * Purpose of meetings * Roles of chairperson, secretary, treasurer and member in a meeting * Documents for meetings * Minute taking * Types of discussions * Dynamics of groups | * Oral * Written * Practical |
| 1. Conduct Presentations | * Types of presentations and techniques * Development of a presentation * Steps to successful oral presentations | * Oral * Written * Practical |
| 1. Manage conflict in an organization | * Definition of terms * Types of conflict * Causes of conflicts in the organization * Nature and impact of conflicts * Methods of conflict management | * Oral * Written * Practical |

**Suggested Delivery Methods**

* Discussion
* Role playing
* Simulation
* Direct instruction
* Practice by trainee

**Recommended Resources**

* Computers
* Internet connection
* Projectors

## NUMERACY SKILLS

**UNIT CODE:** DA/CU/FM/BC/02/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Demonstrate numeracy skills

**Duration of Unit:** 60 hours

**Unit Description**

This unit describes the competencies required by a worker in order to apply a wide range of mathematical calculations for work; apply ratios, rates and proportions to solve problems; estimate, measure and calculate measurement for work; Use detailed maps to plan travel routes for work; Use geometry to draw and construct 2D and 3D shapes for work; Collect, organize and interpret statistical data; Use routine formula and algebraic expressions for work and use common functions of a scientific calculator

**Summary of Learning Outcomes**

1. Apply a wide range of mathematical calculations for work
2. Apply ratios, rates and proportions to solve problems
3. Estimate, measure and calculate measurement for work
4. Use detailed maps to plan travel routes for work
5. Use geometry to draw and construct 2D and 3D shapes for work
6. Collect, organize and interpret statistical data
7. Use routine formula and algebraic expressions for work
8. Use common functions of a scientific calculator

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply a wide range of mathematical calculations for work | * Fundamentals of mathematics * Addition, subtraction, multiplication and division of positive and negative numbers * Algebraic expressions manipulation * Forms of fractions, decimals and percentages * Expression of numbers as powers and roots | * Written tests * Assignments * Supervised exercises |
| 1. Apply ratios, rates and proportions to solve problems | * Rates, ratios and proportions * Meaning * Conversions into percentages * Direct and inverse proportions determination * Performing calculations * Construction of graphs, charts and tables * Recording of information | * Written tests * Oral questioning * Assignments * Supervised exercises |
| 1. Estimate, measure and calculate measurement for work | * Units of measurements and their symbols * Identification and selection of measuring equipment * Conversion of units of measurement * Perimeters of regular figures * Areas of regular figures * Volumes of regular figures * Carrying out measurements * Recording of information | * Assignments * Supervised exercises * Written tests |
| 1. Use detailed maps to plan travel routes for work | * Identification of features in routine maps and plans * Symbols and keys used in routine maps and plans * Identification and interpretation of orientation of map to North * Demonstrate understanding of direction and location * Apply simple scale to estimate length of objects, or distance to location or object * Give and receive directions using both formal and informal language * Planning of routes * Calculation of distance, speed and time | * Oral * Written * Practical test * Observation |
| 1. Use geometry to draw and construct 2D and 3D shapes for work | * Identify two dimensional shapes and routine three-dimensional shapes in everyday objects and in different orientations * Explain the use and application of shapes * Use formal and informal mathematical language and symbols to describe and compare the features of two-dimensional shapes and routine three-dimensional shapes * Identify common angles * Estimate common angles in everyday objects * Evaluation of unknown angles * Use formal and informal mathematical language to describe and compare common angles * Symmetry and similarity * Use common geometric instruments to draw two dimensional shapes * Construct routine three dimensional objects from given nets |  |
| 1. Collect, organize and interpret statistical data | * + Classification of data * Grouped data * Ungrouped data   + Data collection * Observation * Recording   + Distinguishing between sampling and census   + Importance of sampling   + Errors in sampling   + Types of sampling and their limitations e.g. * Stratified random * Cluster * Judgmental   + Tabulation of data * Class intervals * Class boundaries * Frequency tables * Cumulative frequency   + Diagrammatic and graphical presentation of data e.g. * Histograms * Frequency polygons * Bar charts * Pie charts * Cumulative frequency curves * Interpretation of data | * Assignments * Supervised exercises * Written tests |
| 1. Use routine formula and algebraic expressions for work | * + Solving linear equations   + Linear graphs * Plotting * Interpretation   + Applications of linear graphs * Curves of first and second degree * Plotting * Interpretation | * Assignments * Supervised exercises * Written tests |
| 8. Use common functions of a scientific calculator | * Identify and use keys for common functions on a calculator * Calculate using whole numbers, money and routine decimals and percentages * Calculate with routine fractions and percentages * Apply order of operations to solve multi-step calculations * Interpret display and record result | * Oral * Written * Practical test * Observation |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Practical work by trainee
* Exercises

**Recommended Resources**

* Calculators
* Rulers, pencils, erasers
* Charts with presentations of data
* Graph books
* Dice

## DIGITAL LITERACY

**UNIT CODE:** WAT/CU/IDET/BC/02/6A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **demonstrate digital literacy**

**Duration of Unit:** 60 Hours

**Unit Description**

This unit covers the competencies required to demonstrate digital literacy. It involves applying computer hardware software, internet and cyber security principles.

**Summary of Learning Outcomes**

1. Apply computer hardware
2. Apply computer software
3. Apply internet
4. Apply ICT security

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply computer hardware | * Concepts and principles of ICT * Classification of computers * Components of a computer hardware * Cabling computer * Starting and shutting a computer | * Written tests * Oral presentation * Observation * Practical assignment |
| 1. Apply computer software | * Operating systemsbasics * Classification of computer software * ICT data collection techniques * Word processing * Spread sheets * Data manipulation * Data storage and retrieval * Presentation * Printing * Mobile phone applications | * Written tests * Oral presentation * Observation * Practical assignment |
| 1. Apply internet | * Computer networks basics * Electronic mail * Worldwide web concepts * Internet search engines * Social media and phone etiquette * Internet ethics | * Written tests * Oral presentation * Observation * Practical assignment |
| 1. Apply Cybersecurity principles | * Concepts of cyber security * Data security * Detection and control against cyber crimes * Cybersecurity legislation | * Oral questioning * Observation * Oral presentation * Written report * Project |

**Suggested Delivery Methods**

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

**Recommended Resources**

* Desktop computers
* Laptop computers
* Other digital devices
* Printers
* Storage devices
* Internet access

## ENTREPRENEURIAL SKILLS

**UNIT CODE:** WAT/CU/IDET/BC/03/6A

**Relationship to occupational standards**

This unit addresses the unit of competency: **demonstrate entrepreneurial skills**

**Duration of unit:** 90 Hours

**Unit description**

This unit covers competencies required to demonstrate entrepreneurial skills. It involves developing innovative business strategies, new products and markets, motivating staff, expanding business capital, expanding business and applying government policies in business.

**Summary of Learning Outcomes**

1. Develop innovative business strategies
2. Develop new products and establishing new markets
3. Motivate staff and workers
4. Expand business capital
5. Expand business
6. Apply government policy in business

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Develop innovative business strategies | * Review Existing business strategies * SWOT analysis * Re-branding of the products for business development * Embracing new technologies in entrepreneurship * Networking with other entrepreneurs * Business conventions and exhibitions * New ideas and approaches * Entrepreneurial skills enhancement * Setting strategic directions * Business growth refocus | * Observation * Case studies * Individual * Group assignments * Projects * Written * Oral |
| 1. Develop new products and establishing new markets | * Feasibility study for new products * New sources of raw material and resources * New target markets/customers * Marketing improvement * Market trends * Monitoring and anticipating market trends * Marketing mix * Market segmentation and niche * Regulatory environment * Introduce new products and markets | * Observation * Case studies * Individual * Group assignments * Projects * Written * Oral |
| 1. Motivate staff and workers | * Motivation of staff and workers * Change management * Good staff and worker relations * Team-building and teamwork * Staff development, career progression * Cultural integration | * Observation * Case studies * Individual * Group assignments * Projects * Written * Oral |
| 1. Expand business capital | * Sources of business finance * Refinancing activities * Factors considered in choosing finance options * Access to finance | * Observation * Case studies * Individual * Group assignments * Projects * Written * Oral |
| 1. Expand business | * Reasons for business expansion * Strategies for business expansion * Areas for business expansion * Revised Strategic Plan * Technological advancement * Business expansion | * Observation * Case studies * Individual * Group assignments * Projects * Written * Oral |
| 1. Apply government policy in business | * Government legal framework * Contracting * Business ethics * Social responsibilities and entrepreneurship * Regulations | * Observation * Case studies * Individual * Group assignments * Projects * Written * Oral |

**Suggested Delivery Methods**

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

**Recommended Resources**

* Case studies for small businesses
* Laptop/ desktop computers
* Internet
* Telephone
* Writing materials
* Field Exposure

## EMPLOYABILITY SKILLS

**UNIT CODE:** WAT/CU/IDET/BC/04/6A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **DEMONSTRATE EMPLOYABILITY SKILLS**

**Duration of Unit:** 45 Hours

**Unit Description**

This unit covers competencies required to demonstrate employability skills. It involves developing self-awareness, demonstrating acceptable work habits, establishing team work and managing work. It also involves maintain professional development, demonstrating learning, creativity and innovativeness in work place and establishing checks and balances at the workplace.

**Summary of Learning Outcomes**

1. Develop work place self-awareness
2. Demonstrate acceptable work habits for employees in the workplace
3. Establish teamwork
4. Manage work
5. Maintain professional development in the workplace
6. Demonstrate learning, creativity and innovativeness in the workplace
7. Establish checks and balances in the work place

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Develop work place self-awareness | * Self-awareness * Managing emotions * Assertiveness versus aggressiveness * Self-esteem * Behavioural change * Formulating personal vision, mission and goals * Developing work goals * Monitoring and evaluation of work activities * Strategies for overcoming life challenges | * Observation * Written * Oral interview * Third party report |
| 1. Demonstrate acceptable work habits for employees in the workplace | * Integrating personal objectives into organizational objectives * human rights awareness in the workplace * Time concept * Personal grooming * Appropriate resource utilization * Stress and stress management * HIV and AIDS awareness * Drug and substance abuse awareness * Dealing with emerging issues * Leisure | * Observation * Written * Oral interview * Third party report |
| 1. Establish teamwork | * Leadership * Formation of teams * Determination of team roles and objectives * Rules and regulations governing teams * Individual responsibilities in a team * Complementing team activities * Giving equal opportunities to all gender * Maintaining relationships * Manage conflicts in teams | * Observation * Oral interview * Written * Third party report |
| 1. Manage work | * Planning * Organizing * Staffing * Directing * Controlling managerial functions including reporting | * Observation * Oral interview * Written * Third party report |
| 1. Maintain professional development in the workplace | * Avenues for professional growth * Assessing training needs/appraisals * Mobilizing training resources * Training and career opportunities * Licenses and certifications for professional growth and development * Recognizing career advancement | * Observation * Oral interview * Written * Third party report |
| 1. Demonstrate learning, creativity and innovativeness in the workplace | * Managing own learning * Mentoring * Coaching * Networking * Use of technology * Application of knowledge * Taking proactive initiative * Receptive to new ideas * Identifying new opportunities * Workplace innovation * Performance improvement | * Observation * Oral interview * Written |
| 1. Establish checks and balances in the work place | * Concept of checks and balances * Importance of checks and balances * Internal control systems | * Observation * Oral interview * Written * Third party reports |

**Suggested Methods of Delivery**

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

**Recommended Resources**

* Computers
* Stationery
* Charts
* Video clips
* Audio tapes
* Projectors

## ENVIRONMENTAL LITERACY

**UNIT CODE:** WAT/CU/IDET/BC/05/6A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **demonstrate environmental literacy**

**Duration of Unit:**90 Hours

**Unit Description**

This unit covers the competencies required to demonstrate environmental literacy. It involves demonstrating environmental sustainability, controlling environmental hazard, environmental pollution and applying environmental legislations/conventions for environmental concerns. It also involves implementing specific environmental programs to address environmental issues and mitigating effects of Climate change and variability.

**Summary of Learning Outcomes**

1. Demonstrate environmental sustainability
2. Control environmental hazard
3. Control environmental pollution
4. Apply Environmental legislations/conventions for environmental concerns
5. Implement specific environmental programs
6. Mitigate effects of Climate change and variability

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Demonstrate environmental sustainability | * Natural environment * Manmade environment * Ecosystems * Natural resources use * Green energy * Waste management procedures * Principles of 5Rs in environmental management * Principles of cleaner production * Concept of sustainable development | * Observation * Oral interview * Written * Third party report |
| 1. Control environmental hazards | * Environmental hazards * Impacts of environmental hazards * Environmental risks assessment * Mitigation plans | * Written tests * Observation * Interviewin * Third party reports |
| 1. Control environmental pollution | * Environmental pollution * Fate and transport of pollutants in the environment * Environmental pollutants * Environmental pollution control measures * Constructed wetlands | * Written tests * Interviewing * Third party reports |
| 1. Apply environmental legislations and conventions for environmental concerns | * Constitution of Kenya on environment * Environmental issues and concerns * Industrial standards * Environmental legislations and regulations * Environmental Impact Assessment and Environmental Audit * Environmental Ethics * Code of ethics for water resources, water supply and sanitation technicians/technologists in kenya * National values applications in water sector | * Written tests * Oral questioning * Third party reports |
| 1. Implement specific environmental programs to address environmental issues | * Community needs and expectations * Resource availability * Setting of individual roles and responsibilities * Solving problems encountered and constraints * Stakeholder consultation | * Written tests * Oral questioning * Third party report |
| 1. Mitigate effects of Climate change and variability | * Green house gases * Global warming and climate change * Adaptability and coping of climate change at different environments * Mitigation of Climate change | * Written tests * Oral questioning * Third party report |

**Suggested Methods of Delivery:**

* Direct instructions
* Projects
* Case studies
* Field trips
* Discussions
* Demonstration by trainer
* Practice by the trainee

**List of Recommended Resources:**

* Computers
* Stationery
* SOPS
* Procedures manuals
* Specific job procedures manuals
* EMCA,2015 EIA guidelines\*
* Constitution of Kenya
* Machine/equipment manufacturer’s specifications and instructions
* Personal Protective Equipment
* ISO standards 14001:2015\*
* Online resources

## OCCUPATIONAL SAFETY AND HEALTH PRACTICES

**UNIT CODE:** WAT/CU/IDET/BC/06/6A

**Relationship to Occupational Standards**

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

**Duration of Unit:** 30 Hours

**Unit Description**

This unit covers competences required to demonstrate occupational safety and health practices. It involves identifying workplace hazards, assessing risks in the work place, implementing risk control measures and OSH policies, guidelines and procedures.

**Summary of Learning Outcomes**

1. Identify workplace hazards and risks
2. Assess risks in the workplace
3. Implement control measures to hazards and risks
4. Implement OSH policies, guidelines, programs and procedures

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify workplace hazards | * Occupational safety terminologies * Classification of workplace hazards and their indicators * Fire hazards and causes * Safety signage in workplace * OSH concerns in the workplace | * Oral questioning * Written tests * Observation |
| 1. Assess risks in workplace | * Safety conditions in the workplace * Degrees of risk * Risk assessment * Reporting on risks | * Oral questioning * Written tests * Observation |
| 1. Implement appropriate control measure to hazards | * Safety precautionary and control measures * Classes of fire * Fire prevention measures * Extinguishing methods * workplace contingency measures * Documentation of the control measures and incidents | * Oral questioning * Written tests * Practical tests * Observation |
| 1. Implement OSH policies, guidelines and procedures | * National safety objectives * Humanitarian, Legal and Economic obligation in OSH * OSH policies, guidelines and procedures * Implementation of national policies, guidelines and procedures * Training of team members on OSH standards and procedures * Stewardship in maintenance of OSH procedures and records | * Oral questioning * Written tests * Practical test * Observation |

**Suggested Delivery Methods**

* Introductory instructions
* Demonstration by trainer
* Practical work by trainee
* Viewing of related videos
* Group work and role play
* Simlulation

**Recommended Resources**

* SOPs
* Hazard signs
* Specific procedures manuals
* equipment manufacturer’s specifications and instructions
* Fully stocked and up to date First aid kit
* Firefighting equipment
* Fire detection systems
* Personal Protective Equipment

# COMMON UNITS OF LEARNING

## WATER QUALITY PRINCIPLES

**UNIT CODE:** WAT/CU/IDET/CC/01/6A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **APPLY WATER QUALITY PRINCIPLES**

**Duration of Unit:**60 HOURS

**Unit Description**

This unit covers the competencies required to apply water quality principles. It involves applying inorganic chemistry principles, organic chemistry principles, physical chemistry principles, water chemistry principles, chemical water quality principles and microbial water quality principles.

**Summary of Learning Outcomes**

1. Apply inorganic chemistry principles
2. Apply organic chemistry principles
3. Apply physical chemistry principles
4. Apply water chemistry principles
5. Apply chemical water quality principles
6. Apply biology principles
7. Apply water microbiological principles

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

|  |  |  |  |
| --- | --- | --- | --- |
| Learning Outcome | Content | Suggested Assessment Methods | |
| 1.Apply inorganic chemistry principles | * Atomic structure and the periodic table * Electronic configuration of the first 30 elements of the periodic table * Groups, periods and blocks in the periodic table * Trends in physical and chemical properties of main group elements * Chemical bonding and structures * Properties of metallic, covalent and Ionic bonds * Nomenclature and chemical formulae of inorganic compounds * Dissolution and hydrolysis of ionic compounds of period 3 elements * The mole concept and aqueous solutions * Stoichiometry of chemical reactions * Chemical reagents and solution preparation * GHS of classification and labelling of chemicals * Storage, packaging, transportation, handling and disposal of hazardous chemical wastes * Personal safety and chemical accidents prevention | * Observation * Interviewing * Oral questioning * Third party report * Written tests | |
| 2. Apply organic chemistry principles | * Classification of organic compounds * Structure and nomenclature of organic compounds * Chemical reactions of alkanes and alkenes * Natural and synthetic polymers * Aerobic and anaerobic processes * Eutrophication | * Observation * Interviewing * Oral questioning * Third party report * Written tests | |
| 3. Apply Physical Chemistry Principles | * Electrochemical series and reactivity series * Corrosion * Displacement reactions * Solubility rules * Chemical reactions in electrochemical cells * Kinetic theory and gas laws * Reversible reactions and chemical equilibria * Chemical kinetics * Thermochemistry and thermodynamics * Rate law applications in aqueous medium * Colloidal suspensions | * Observation * Interviewing * Oral questioning * Third party report * Written tests | |
| 4.Apply water Chemistry Principles | * Structure and chemical composition of water * Acid-base phenomena * Properties of water * Solubility of fluids in water * Chemical equilibria in the carbonate system * Auto-ionization and levelling effect of water * Implications of unique chemistry of water | * Observation * Interviewing * Oral questioning * Third party report * Written tests | |
| 5. Apply chemical water quality principles | | * Water quality and effluent discharge standards and guidelines * Irrigation water quality regulations * Water and wastewater sampling techniques for chemical teting * Protocols for physical and chemical analysis * Physical and chemical water quality analysis principles, and applications * Physical and chemical tests for drinking water, irrigation water and waste water. * Data collection, recording, interpretation and reporting * Safety considerations in a chemical water and wastewater quality testing laboratory | | * Observation * Interviewing * Oral questioning * Third party report * Written tests | |
| 1. Apply Biology principles | * Concepts and terms of Biology * Characteristics of living things * Organization of life forms * The five kingdom classification system * Viruses * Prokaryotes and eukaryotes * Unicellular and multicellular organisms * Classification of aquatic organisms * Principles of aquatic ecology * Application of aquatic ecology in water quality monitoring * Classification of pathogenic microorganisms and their vectors * General laboratory biosafety rules | | * Observation * Interviewing * Oral questioning * Third party report * Written tests |
| 1. Apply microbial water quality principles | * Water sampling for microbial analysis * Microbial water quality analysis principles and application * Microbiological water quality testing | | * Observation * Interviewing * Oral questioning * Third party report * Written tests |

**Suggested Methods of Delivery:**

* Direct instructions
* Projects
* Case studies
* Field trips
* Discussions
* Online videos
* Power point presentation
* Demonstration by trainer
* Practice by the trainee

**List of Recommended Resources:**

|  |  |
| --- | --- |
| * Analytical balances * UV-Vis spectrophotometers * Colour comparator discs * pH meter * Conductivity meter * Meters with ISE e.g. fluoride, nitrate * Turbidimeter * Conductivity meters * Dissolved oxygen meter * BOD oxitop bottles * Oven * Incubator * Muffle furnace (up to 500oC) * Refrigerator * Cooler boxes * jar test kit * Membrane filtration units * Thermometers * Distillers * filtration units * Autoclaves * Microscope * Quant tray sealer * Desiccators * Hotplates * Magnetic stirrers * Computers * Vacuum Pumps |  |

## APPLIED PHYSICS

**UNIT CODE:** WAT/CU/IDET/CC/02/6A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **APPLY PHYSICS PRINCIPLES**

**Duration of Unit:** 90 hours

**Unit Description**

This unit describes the competence required to apply physics principles. It involves performing measurements of physical quantities, applying principles of forces, classical mechanics, heat transfer, waves and oscillations, as well as density and pressure principle. It also entails applying electromagnetic induction principles.

**Summary of Learning Outcomes**

1. Perform measurements of physical quantities
2. Apply principles of classical mechanics
3. Apply principles of heat transfer
4. Apply principles of waves and oscillations
5. Apply density, pressure and fluid flow principles
6. Apply electrical and electronics principles
7. Apply principles of electromagnetic induction

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform Measurements of physical quantities | * Basic physical quantities and SI units * Derived units * Measurement of the physical quantities * Unit interconversions | * Oral questioning * Written tests * Observation * Practical test |
| 1. Apply Principles of classical Mechanics | * Concepts and terms in classical mechanics * Linear Motion * Projectile motion * Newton’s laws of motion * Linear momentum * Potential energy * Kinetic energy * Conservation of energy * Solving problems | * Observation * Oral uestioning * Practical tests * Written tests |
| 1. Apply principles of heat Transfer | * Concepts and terms in heat transfer * Modes of heat transfer * Change of physical state * Temperature change * Latent heat * Specific heat capacity * Quantity of heat * Kinetic theory | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Apply principles of waves and oscillations | * Principles and terms in waves and oscillation * Types of waves * Wave equation * Electromagnetic spectrum * Dual nature of light * Rectlinear propagation of light * Optical properties of light * Simple harmonic oscillations * Vibration * Solving problems | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Apply density, pressure and fluid flow principles | * Density in fluids and solids * Pressure in fluids and solids * Bernoulli’s Principle * Equation of continuity * Hydraulic machines * Sunction pumps * Application of pressure in hydraulic machines | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Apply electrical and electronic principles | * Concepts and terminology in electricity and electronics * Electric charges and current * Electric Circuits * Electrical instruments * Electrical measurement * Errors in electrical measurement * Ohms law * Kirchhoff’s laws * AC and DC circuits in electronic systems * Electrical and electronic installation * R-L-C circuits | * Observation * Oral questioning * Practical * Written tests |
| 1. Apply Principles of Electromagnetic Induction | * Concepts and terminology in electromagnetic induction * Magnetic parameters * Magnetic properties of materials * induced e.m.f. and current * Faraday’s laws of electromagnetic induction * Lenz’s law * Applications of electromagnetic induction | * Observation * Oral questioning * Practical * Written tests |

**Suggested Methods of Delivery**

* Direct instruction
* Demonstration by trainer
* Practice by the trainee
* Discussions

**Recommended Resources**

* Electric meters
* PPE
* Assorted cables and wires
* Measuring rules
* Optical bench
* Mirrors
* Lenses

## ENGINEERING MATHEMATICS

**UNIT CODE:** WAT/CU/IDET/CC/03/6A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **APPLY ENGINEERING MATHEMATICS**

**Duration of Unit:** 150 hours

**Unit Description**

This unit describes the competencies required to apply engineering mathematics. It involves applying algebra, trigonometry and hyperbolic functions, complex numbers, co-ordinate geometry and carrying out binomial expansion. It also involves applying calculus, solving ordinary differential equations; carrying out mensuration, power series, statistics, numerical methods, vector theory and matrices.

**Summary of Learning Outcomes**

1. Apply Algebra
2. Apply Trigonometry and hyperbolic functions
3. Apply complex numbers
4. Apply Coordinate Geometry
5. Carry out Binomial Expansion
6. Apply Calculus
7. Solve Ordinary differential equations
8. Carry out Mensuration
9. Apply Power Series
10. Apply Statistics
11. Apply Numerical methods
12. Apply Vector theory
13. Apply Matrix

**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 * Definition of hyperbolic equations * Properties of hyperbolic functions * Evaluations of hyperbolic functions Hyperbolic identities * Osborne’s Rule * Ashx+bshx=C equation * One-to-one relationship in functions * Inverse functions for one-to-one relationship * Inverse functions for trigonometric functions * Graph of inverse functions * Inverse hyperbolic functions | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * + 1. Apply complex numbers | * Definition 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 Power series using binomial theorem Roots of numbers using binomial theorem. * Estimation of errors of small changes using binomial theorem. | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * + 1. Apply Calculus | * Definition of derivatives of a function * Differentiation from fist principle * Tables of some common derivatives * Rules of differentiation * Rate of change and small change * Stationery points of functions of two variables * Definition of integration * Indefinite and definite integral * Methods of integration application of integration. * Integrals of hyperbolic and inverse functions | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * + 1. Solve Ordinary differential equations | * Types of first order differential equations * Formation of first order differential equation * Solution of first order differential equations * Application of first order differential equations * Formation of second order differential equations for various systems * Solution of second order differential equations * Application of second order differential equations | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * + 1. Carry out Mensuration | * Units of measurements * Perimeter and areas of regular figures * Volume of regular solids * Surface area of regular solids * Area of irregular figures * Areas and volumes using Pappus theorem | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * + 1. Apply Power Series | * Definition of the term power series * Taylor’s theorem * Deduction of McLaurin’s theorem to obtain power series * Application of Taylor’s theorem and McLaurin’s theorems in numerical work | * Written tests * Oral questioning * Assignments * Supervised exercises |
| * + 1. Apply Statistics | * 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 Numerical methods | * Definition 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 Vector theory | * Vectors and scalar in two and three dimensions * Operations on vectors: Addition and Subtraction * Position vectors * Resolution of vectors | * Assignments * Oral questioning * Supervised exercises * Written tests |
| * + 1. Apply Matrix methods | * Matrix operation * Determinant of 3x3 matrix * Inverse of 3x3 matrix * Solution of linear simultaneous equations in 3 unknown * Application of matrices | * Assignments * Oral questioning * Supervised exercises * Written tests |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Exercises by trainee

**Recommended Resources**

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

## ELECTRICAL AND MECHANICAL TECHNIQUES

**UNIT CODE:** WAT/CU/IDET/CC/04/6A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **APPLY ELECTRICAL AND MECHANICAL TECHNIQUES**

**Duration of Unit:** 60 Hours

**Unit Description**

This unit describes the competence required to apply electrical and mechanical techniques. It involves, applying electrical and electronic principles, operating and maintaining electrical appliances as well as operating and maintaining alternative power sources. It also involves applying pump working principles.

**Summary of Learning Outcomes**

1. Apply electrical and electronic principles
2. Operate and maintain electrical appliances and instruments
3. Apply pump working principles

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply electrical and electronic principles | * Concepts and terminology in electricity and electronics * Electric charges and current * Electric Circuits * Electrical instruments * Electrical measurement * Errors in electrical measurement * Ohms law * Kirchhoff’s laws * AC and DC circuits in electronic systems * Electrical and electronic Installations * R-L-C circuits | * Observation * Oral questioning * Practical * Written tests |
| 1. Operate and maintain electrical appliances and instruments | * Working principles of alternative sources of power * Operation and maintenance of alternative sources of power | * Observation * Oral questioning * Practical * Written tests |
| 1. Apply pump working principles | * Concepts and terminology in pumps * Types of pumps * Working principles of pumps * Pump selection criteria * Pump performance parameters * Fluid pumping calculations * Pumping plant operation and maintenance | * Observation * Oral questioning * Practical * Written tests |

**Suggested Methods of Delivery**

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

**Recommended Resources**

* Electric meters
* Assorted cables and wires
* Measuring rules and tapes
* Assorted cable joining kits
* Generators
* Solar panels
* Pumps
* Basic repair kits
* Motors
* IEE regulations
* Personal protective equipment
* Organizational procedures manual

## WORKSHOP TECHNOLOGY

**UNIT CODE:** WAT/CU/IDET/CC/05/6A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **Apply workshop technology**

**Duration of Unit:** 210 Hours

**Unit Description**

This unit describes the competence required to apply workshop technology. It involves applying workshop safety regulations, identifying engineering materials, performing masonry tasks, carpentry tasks, general electrical tasks and mechanical tasks. It also involves managing workshop wastes.

**Summary of Learning Outcomes**

1. Apply workshop safety measures
2. Identify engineering materials
3. Perform masonry tasks
4. Perform carpentry tasks
5. Perform general electrical tasks
6. Perform plumbing and pipefitting tasks
7. Perform general welding tasks
8. Perform basic mechanical tasks
9. Manage workshop wastes

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply workshop safety measures | * Safety requirements in the workshop * Workshop rules and regulations * Electrical, mechanical, chemical and fire hazards * First Aid * Environmental management laws and regulations * Waste management and disposal | * Oral questioning * Written tests * Observation * Practical test |
| 1. Identify engineering materials | * Classification of engineering materials * Crystalline structure of materials * Properties of materials * Construction material: types, standard processing and applications | * Oral questioning * Written tests * Observation * Practical test |
| 1. Perform masonry tasks | * Masonry tools and machinery * Masonry works supplies and materials * Tasks in masonry work * Troubleshoot, care and maintenance of masonry tools | * Observation * Oral questioning * Practical tests * Written test |
| 1. Perform carpentry tasks | * Carpentry tools and machinery * Carpentry works supplies and materials * Carpentry work * Troubleshoot, care and maintenance of carpentry tools | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Perform general electrical tasks | * Electrical tools and machinery * Electrical works supplies and materials * Wiring * Troubleshoot, care and maintenance of electrical system | * Observation * Oral questioning * Practical tests * Written tests |
| 1. Perform plumbing and pipefitting tasks | * Plumbing and pipefitting tools and machinery * Plumbing and pipefitting works supplies and materials * Pipes, fittings and appurtenances * Installation of piping system * Troubleshoot, care and maintenance of piping system | * Observation * Oral questioning * Practical tests * Written |
| 1. Perform General welding tasks | * Welding hand tools and machinery * Welding works supplies and materials * Welding methods * Troubleshoot, care and maintenance of welding tools | * Observation * Oral questioning * Practical tests * Written |
| 1. Perform basic mechanical tasks | * Use of mechanical hand tools and machinery * Lifting equipment * Types of lifting equipment: manual, mechanized, hydraulic and pneumatic * Operation principles: pre-requisite checks, operation procedures, equipment safety. * Troubleshoot, care and maintenance of mechanical tools * Routine maintenance: cleaning, servicing and trouble shoot * Mechanical works supplies and materials * Tasks in mechanical work | * Observation * Oral questioning * Practical tests * Written |
| 1. Manage workshop wastes | * Environmental management laws and regulations * Waste management and disposal * Storage products and supplies * Waste management methods * Waste disposal methods * Work station cleaning procedure | * Practical tests |

**Suggested Methods of Delivery**

* Demonstration by trainer
* Practice by the trainee
* Field trips
* On-job-training
* Discussion
* Direct instruction

**Recommended Resources**

|  |  |
| --- | --- |
| **Tools**   * Masons trowel * Adjustable wrench * Anvil * Arc welding shields * Chain pipe wrench * die stock and die sets * draw in wire * Hacksaw * Hand drill * Pullers * Solder gun * Spirit level * Vernier callipers * Welding goggles | **Materials and supplies**   * Aggregates * Assorted pipe joints * Brushes * Cement * Glue * Hemp * Insulation tape * Nails * Pipe cleaner * Solvent Cement * Thread tape * Timber * Trunking |
| **Machinery and Equipment**   * Block cutter * Butt fusion machine * circular saw * Close cut saw * Compactors * Concrete mixer * Electrical Die stock machine * Hand grinder * Pipe Bending machine * Pneumatic hammer * Portable drill machine * Portable power drill * Portable sander * PPR Welding machine * Sheet metal holding machine * Thicknesser * Tool box * Vibrator * Welding * Jig saw | **Reference materials**   * IEE regulations * Organizational procedures manual |
| **Instruments**   * Voltmeter * Ammeter * Frequency meter * Phase sequence |  |

## TECHNICAL DRAWING AND COMPUTER AIDED DRAWING

**UNIT CODE:** WAT/CU/IDET/CC/06/6A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: APPLY TECHNICAL DRAWING AND COMPUTER AIDED DRAWING DESIGN PRINCIPLES

**Duration of Unit:** 210 Hours

**Unit Description**

This unit covers the competencies required to apply technical drawing and computer aided design principles It involves using and maintaining drawing equipment and materials, producing plane geometry drawings, solid geometry drawings, 3D drawings, and working drawings It also involves applying CAD packages in producing working drawings.

**Summary of Learning Outcomes**

1. Use and maintain drawing equipment and materials
2. Produce plane geometry drawings
3. Produce solid geometry drawings
4. Produce 3D drawings
5. Produce working 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 | * Drawing office set up * Drawing tools, materials and equipment | * written test * interviews * supervised exercises * Practical tests * Observation * Third party report |
| 1. Produce plane geometry drawings | * Drawing lines * Lettering and numbering * Drawing scales * Construction of angles, lines and tangents * Geometric forms | * written test * interview * supervised exercises * Practical tests * Observation * Third party report |
| 1. Produce solid geometry drawings | * Drawing patterns * Surface developments * True shapes, plans and elevations * Free hand sketching | * written test * interview * supervised exercises * Practical tests * Observation * Third party report |
| 1. Produce 3D drawings | * Pictorial projections * Orthographic projections | * written test * interview * supervised exercises * Practical tests * Observation * Third party report |
| 1. Produce working drawings | * Construction plans, elevation and sections * Irrigation and drainage structures | * written test * interview * supervised exercises * Practical tests * Observation * Third party report |
| 1. Apply CAD packages | * Introduction to CAD * 2D drawing * 3D drawing * Page Layout and Printing | * written test * supervised exercises * Practical tests * Observation * Third party report |

**Suggested Delivery Methods**

* Online videos
* Exercises by trainee
* Demonstration by trainer
* Power point presentation
* Group discussions
* Direct instruction by trainer

**Recommended Resources**

* Relevant reference materials
* Stationeries
* Design Software
* Computer lab
* Relevant practical materials
* Internet

## WATER TECHNOLOGY PRINCIPLES

**UNIT CODE:** WAT/CU/IDET/CC/07/6A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **APPLY WATER TECHNOLOGY PRINCIPLES**

**Duration of Unit:**90 Hours

**Unit Description**

This unit describes the competence required to apply water technology principles. It involves applying water supply principles and wastewater characterization, treatment and re-use.

**Summary of Learning Outcomes**

1. Apply water supply principles
2. Apply principles of wastewater characterization, treatment and re-use

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply water supply principles | * Water demand * Sources of water * Water abstraction * Water treatment * Safe water storage and handling * Water pipes and appurtenances * Distribution system | * Oral questioning * Written tests * Observation * Practical test |
| 1. Apply principles of wastewater characterization and treatment | * Characteristics of wastewater * Sources of waste water * Waste water treatment process * Use of waste water for irrigation | * Oral questioning * Written tests * Observation * Practical test |

**Suggested Methods of Delivery**

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

**Recommended Resources**

* Stationery
* Basic engineering workshops
* Soil quality laboratory
* Demonstration platforms
* Computers
* Internet

## SOIL AND CROP SCIENCE

**UNIT CODE:** WAT/CU/IDET/CC/08/6A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **SOIL AND CROP PRINCIPLES.**

**Duration of Unit:**120 Hours

**Unit Description**

This unit describes the competencies required to apply soil and crop science principles. In involves determining soil properties, identifying fertilizer, determining soil, water plant relationship, determining crop water relationship, determining crop water requirements, developing cropping programme, developing crop husbandry schedule and establishing harvesting and post-harvest processing schedule.

**Summary of Learning Outcomes**

1. Determine soil properties
2. Identify inorganic and organic fertilizers
3. Determine soil plant water relationship
4. Determine crop water requirement
5. Develop cropping programme
6. Implement crop husbandry schedule
7. Establish harvesting and post-harvest processing schedule

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Determine soil properties | * Soil classification * Soil texture * Soil structure * Soil PH * Soil salinity * Soil sodicity * Soil organic matter * Soil micro-bilogy | * Oral questioning * Written tests * Observation |
| 1. Identify Inorganic and organic fertilizers | * Organic fertilizers * Inorganic fertilizers * Application methods | * Oral questioning * Written tests * Observation |
| 1. Determine soil plant water relationship | * Soil saturation * Field capacity * Permanent wilting point * Plant Available Water * Evapo-transpiration * Soil minerals and water movement in soil * Water and mineral absorption by plants * Methods of measurements | * Oral questioning * Written tests * Observation * Oral questioning * Written tests * Observation |
| 1. Determine crop water requirements | * Reference crop evapotranspiration * Crop coefficient * Models for determining crop water requirements | * Oral questioning * Written tests * Observation |
| 1. Cropping programme | * Cropping cycle * Farm layout | * Oral questioning * Written tests * Observation |
| 1. Implement a crop husbandry schedule | * Irrigation methods * Sowing * Transplanting * Crop protection * Fertilizer application * Weeding * Relevant equipment and machineries | * Oral questioning * Written tests * Observation |
| 1. Establish a harvesting and postharvest processing schedule | * Post-harvest activities * Harvesting machinery | * Oral questioning * Written tests * Observation |

**Suggested Methods of Delivery**

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

**Recommended Resources**

* Stationery
* Basic engineering workshops
* Soil quality laboratory
* Demonstration platforms
* Computers
* Internet

## WATER RESOURCES MANAGEMENT PRINCIPLES

**UNIT CODE:** WAT/CU/IDET/CC/07/6A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Applywater management principles.

**Duration of Unit:** 60 Hours

**Unit Description**

This unit describes the competencies required to apply water management principles. It involves determining hydrological processes, quantifying surface water, determining rock types and aquifers, establishing suitable well site, developing water harvesting structures and conserving environment. It also involves applying water and environmental law in water resource management and applying water resources management principles.

**Summary of Learning Outcomes**

1. Determine hydrological processes
2. Quantify surface water
3. Determine rocks and aquifers
4. Establish suitable well sites
5. Conserve the Environment
6. Develop water harvesting and storage structures
7. Apply water and environmental law in water resource management
8. Apply Integrated Water Resources Management (IWRM) Principles

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Determine Hydrological Processes | * Concepts of hydrology * Hydrological cycle * Hydrological processes, principles and application | * Written tests * Observation * Interviewing * Oral questioning * Third party report |
| 1. Quantify surface water | * Precipitation * Evaporation * Stream flow * Personal safety in hydrometry | * Written tests * Interviewing * Observation * Third party report |
| 1. Determine rock types and aquifers | * Earth processes * Minerals and Rocks * Aquifers | * Written tests * Interviewing * Observation * Third party report |
| 1. Establish suitable site for well | * Classifications of wells * Well site establishment * Well site establishment report | * Written tests * Interviewing * Observation * Third party report |
| 1. Conserve Environment | * Water conservation * Soil conservation * land degradation | * Written tests * Observation * Interviewing * Third party report |
| 1. Develop water harvesting and structures | * Water harvesting techniques * water harvesting and storage structures * Site selection for water harvesting structures * Runoff concentration * Design of water harvesting and storage structures * Operation and maintenance of water harvesting and storage structures | * Written tests * Interviewing * Observation * Third party report |
| 1. Apply Water Resources Management Principles | * Policy, Legal and regulatory framework of Water Sector in Kenya: * IWRM principles | * Written tests * Observation * Oral questioning * Third party report |

**Suggested Methods of Delivery:**

* Direct instruction
* Project
* Case studies
* Field trips
* Discussions
* Demonstration by trainer
* Practice by the trainee

**List of Recommended Resources:**

|  |
| --- |
| * Computers * Stationery * Evaporation pan (Class A) * Rain gauge * Current meter * Wading suit * Tape measure * Staff gauge * Hand lens * Clinometer * Gps receiver * Maps * Steel file * Steel knife * Rock samples * Minerals * PPE |

**References**

* CoK, 2010
* Water Act,2016
* EMCA, 2015
* WRA regulations ,2007
* WASREB reports
* Local government regulations
* International Protocols

## PRINCIPLES OF FLUID MECHANICS

**UNIT CODE:** WAT/CU/IDET/CC/08/6A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **APPLY PRINCIPLES OF FLUID MECHANICS**

**Duration of Unit:**60 hours

**Unit Description**

This unit describes the competencies required to apply principles of fluid, mechanics. It involves applying properties of fluids, pressure measurements, hydrostatic forces principles, and dynamics of fluid flow principles, fluid flow through pipes, and flow in open channels. It also involves applying principles of hydraulic structures.

**Summary of Learning Outcomes**

Apply fluid mechanics principles

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply properties of fluids | * Density * Viscosity * Surface tension * Capillarity * Compressibility * Bulk modulus | * Written tests * Observation * Interviewing |
| 1. Apply principles of pressure measurements | * Fluid pressure at point * Pascals’ law * Pressure variation * Pressure measurement | * Written tests * Observation * Interviewing |
| 1. Apply Principles of hydrostatic forces on surfaces principles | * Vertical plane surface submerged * Horizontal plain surface submerged * Inclined plane surface submerged * Pressure on lock gates * Pressure distribution | * Written tests * Observation * Interviewing |
| 1. Apply Principles of dynamics of fluid flow | * Motion equations * Application of motion equations * Flow through venturimeter,orifice and pitot tube | * Written tests * Observation * Interviewing |
| 1. Principles of fluid flow through pipes | * Loss of energy in pipes * Hydraulic gradient and total energy line * Flow through pipes in series, branched and parallel * Water hammer in pipeline * Pipe network | * Written tests * Observation * Interviewing |
| 1. Flow in open channels | * Classification of flow in channels * Discharge through open channel by chezy’s formulae * Most economical section of channels * Non uniform flow through open channels * Hydraulic jump | * Written tests * Observation * Interviewing |
| 1. Apply principles of Hydraulic structures | * Notches * Weirs * Dams | * Written tests * Observation * Interviewing |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Online videos
* Power point presentation
* Exercises by trainee
* Academic trips

**Recommended Resources**

* Hydraulics laboratory
* Softwares

## PRINCIPLES OF SOIL MECHANICS

**UNIT CODE:** WAT/CU/IDET/CC/09/6A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **APPLY PRINCIPLES OF SOIL MECHANICS**

**Duration of Unit:** 60 hours

**Unit Description**

This unit describes the competencies required to apply principles of, soil mechanics principles.

**Summary of Learning Outcomes**

Analyse soil properties

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply soil mechanics principles | * Principles of soil mechanics * Soil identification * Soil classification * Shearing characteristics of soil * Seepage, flownet and drainage * Load bearing test * Soil compaction * Soil investigation and sampling | * Written tests * Observation * Interviewing |

**Suggested Delivery Methods**

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

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* GPS
* Computer laboratory
* Relevant practical materials
* Soil laboratory

## PRINCIPLES OF STRUCTURAL MECHANICS

**UNIT CODE:** WAT/CU/IDET/CC/10/6A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **APPLY PRINCIPLES OF STRUCTURAL MECHANICS**

**Duration of Unit:** 60 hours

**Unit Description**

This unit describes the competencies required to apply principles of structural mechanics

**Summary of Learning Outcomes**

1. Analyse structural elements

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply structural mechanics principles | * Concept of structural design * Moments in beams * Section properties * Theory of simple bending * Forces in frames * Deflection in beams. | * Written test * Interviews * Supervised exercises |

**Suggested Delivery Methods**

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

**Recommended Resources**

* Computer laboratory
* Relevant practical materials

# CORE UNITS OF LEARNING

## DESIGN OF IRRIGATION AND DRAINAGE INFRASTRUCTURE

**UNIT CODE:** WAT/CU/IDET/CR/01/6A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **DESIGN IRRIGATION AND DRAINAGE INFRASTRUCTURE**

**Duration of unit:**630 Hours

**Unit Description**

This unit describes the competencies required to design irrigation and drainage infrastructure. It involves conducting feasibility study, identifying irrigation and drainage system components, conducting site survey for irrigation and drainage infrastructure. It also involves designing irrigation and drainage infrastructure.

**Summary of Learning Outcomes**

1. Conduct feasibility study
2. Determine required irrigation and drainage system components
3. Conduct site survey for irrigation and drainage infrastructure
4. Design the irrigation and drainage infrastructure

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Conduct feasibility study | * Characterization of the study area * Tools and methods for data collection and analysis * Preparation of feasibility study report | * Written tests * Observation * Interviewing |
| 1. Determine required irrigation and drainage system components | * Irrigation infrastructure * Drainage infrastructure * Irrigation and drainage components | * Written tests * Interviewing * Observation * Third party   report |
| 1. Conduct site survey for irrigation and drainage infrastructure | * Site reconnaissance * Survey tools and equipment * Site survey * Survey data analysis and presentation * GIS and remote sensings for irrigatated agriculture | * Written tests * Observation * Oral questioning |
| 1. Design irrigation and drainage infrastructure | * Design standards and guidelines * Design materials * Storage structures * Abstraction structures * Water conveyance systems * In field works * Drainage system * Regulatory works * Automated irrigation systems * Solar pumping systems * Engineering drawings and plans * Cost estimations * Project report | * Written tests * Observation * Oral questioning * Third party report |

**Suggested Delivery Methods**

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

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* GPS
* Design software
* Computer lab
* Relevant practical materials
* Laboratories (chemical, biological , soils)
* Internet
* Engineering Standard manual
* Survey workshop

## CONSTRUCTION OF IRRIGATION AND DRAINAGE INFRASTRUCTURE

**UNIT CODE:** WAT/CU/IDET/CR/02/6A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **CONSTRUCT IRRIGATION AND DRAINAGE INFRASTRUCTURE**

**Duration of Unit:** 315 hours

**Unit Description**

This unit covers the competencies required to construct irrigation and drainage infrastructure. It involves Interpreting irrigation and drainage infrastructure design, setting out the design for irrigation and drainage infrastructure, constructing and installing the irrigation and drainage infrastructure. It also involves managing construction works.

**Summary of Learning Outcomes**

1. Interpret irrigation and drainage infrastructure design drawings
2. Set out irrigation and drainage infrastructure
3. Construct and install irrigation and drainage components
4. Manage construction works

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Interpret irrigation and drainage infrastructure design drawings | * Engineering drawings interpretation * Ground truthing * Specification validation | * Written tests * Observation * Interviewing * Third party report |
| 1. Set out irrigation and drainage infrastructure | * Site organization * Project scheduling * Quality assurance plan * Marking out | * Written tests * Observation * Oral questioning * Third party report |
| 1. Construct and install irrigation and drainage components | * Construction materials * Concrete technology * Construction plant * Land grading * Pumping plant * Hydraulic structures * Farm structures * Monitoring and evaluation | * Written tests * Observation * Interviewing * Third party report |
| 1. Manage construction works | * Principles of public participation * Community mobilisation | * Written tests * Observation * Oral questioning * Third party report |

**Suggested Delivery Methods**

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

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* GPS
* Design software
* Computer lab
* Relevant practical materials
* Laboratories

## OPERATION AND MAINTENANCE OF IRRIGATION AND DRAINAGE SYSTEMS

**UNIT CODE:** WAT/CU/IDET/CR/03/6A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **OPERATE AND MAINTAIN IRRIGATION AND DRAINAGE SYSTEMS**

**Duration of Unit:**135 Hours

**Unit Description**

This unit covers the competencies required to operate and maintain irrigation and drainage system. It involves developing a schedule for operation of irrigation and drainage system, carrying out routine operation activities, inspecting irrigation and drainage system, monitoring the performance of the irrigation and drainage system and carrying out routine maintenance for irrigation and drainage systems.

**Summary of Learning Outcomes**

1. Develop a schedule for operation of irrigation and drainage system
2. Carry out routine operation activities
3. Inspect irrigation and drainage system
4. Monitor performance of irrigation and drainage system
5. Carry out routine maintenance of irrigation and drainage system

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Develop a schedule for operation of irrigation and drainage system | * Cropping calendar and its water requirements * Water conveyance and distribution operations * Removal of excess water and salts * Human and financial resource management * Cost of irrigation water/drainage costs | * Written tests * Observation * Interviewing * Oral questioning * Third party report |
| 1. Carry out routine operation activities | * Operation and maintenance needs * Optimal operation and maintenance plans * Resources for operation and maintenance * Operation and maintenance activities | * Written tests * Interviewing * Observation * Oral questions * Third party report |
| 1. Inspect irrigation and drainage system | * Inspection plan * Inspection report | * Written tests * Interviewing * Observation * Oral questions * Third party report |
| 1. Monitor performance of irrigation and drainage system | * Monitoring and evaluation plan * Data collection and analysis * Conflict management * Monitoring report | * Written tests * Interviewing * Observation * Oral questions * Third party report |
| 1. Carry out routine maintenance of irrigation and drainage system | * Maintenance schedule * Maintenance activities report | * Written tests * Observation * Interviewing * Oral questioning * Third party report |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Online videos
* Power point presentation
* Exercises by trainee
* Academic trips

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* GPS
* Design software
* Computer lab
* Relevant practical materials
* Laboratories (chemical, biological , soils)
* Internet