

**REPUBLIC OF KENYA**

**COMPETENCY BASED CURRICULUM**

**FOR**

**WATER ENGINEERING TECHNOLOGY**

**LEVEL 6**

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

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# FOREWORD

The provision of quality education and training is fundamental to the Government’s overall strategy for social economic development. Quality education and training will contribute to achievement Kenya’s development blue print and sustainable development goals.

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

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

It is my conviction that this Curriculum will play a great role towards development of competent human resource for the 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 a shift to CBET to address the mismatch between skills acquired through training and skills needed by industry as well as increase the global competitiveness of Kenyan labour force.

Kenya Water Institute (KEWI) in conjunction with Water Sector Skills Advisory Committee (SSAC), Kenyatta University and Water Service Providers’ Association (WASPA), 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 Methods of Instruction:, 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.

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

I am grateful to the KEWI Academic Board, Technical Committees, TVET CDACC, Water SSAC, expert workers from participating Water Service Providers and all those 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 relevant organizations and key stakeholders.

I appreciate Water Service Providers Association (WASPA), Nairobi City Water and Sewerage Company, and Ruiru-Juja Water and Sanitation Company; as well as Kenyatta University who enabled the development of this Curriculum.

I recognize with appreciation the role of the Water Sector Skills Advisory Committee (SSAC) in ensuring that competencies required by the industry are addressed in this Curriculum. I also thank all stakeholders in the Water 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 water service provision and entire Water sector will acquire competencies that will enable them to perform their work competently.

**CEO/COUNCIL SECRETARY**

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

TABLE OF CONTENTS

[FOREWORD iii](#_Toc71800559)

[PREFACE iv](#_Toc71800560)

[ACKNOWLEDGEMENT v](#_Toc71800561)

[Abbreviations and ACRONYMS viii](#_Toc71800562)

[KEY TO UNIT CODE x](#_Toc71800563)

[COURSE OVERVIEW xi](#_Toc71800564)

[BASIC UNITS OF LEARNING 1](#_Toc71800565)

[COMMUNICATION SKILLS 2](#_Toc71800566)

[DIGITAL LITERACY 6](#_Toc71800567)

[ENTREPRENEURIAL SKILLS 9](#_Toc71800568)

[EMPLOYABILITY SKILLS 13](#_Toc71800569)

[ENVIRONMENTAL LITERACY 20](#_Toc71800570)

[OCCUPATIONAL SAFETY AND HEALTH PRACTICES 25](#_Toc71800571)

[COMMON UNITS OF LEARNING 28](#_Toc71800572)

[WATER QUALITY PRINCIPLES 29](#_Toc71800573)

[ENGINEERING MATHEMATICS 35](#_Toc71800574)

[WORKSHOP TECHNOLOGY 41](#_Toc71800575)

[APPLIED PHYSICS 47](#_Toc71800576)

[TECHNICAL DRAWING AND COMPUTER AIDED DRAWING 50](#_Toc71800577)

[WATER TECHNOLOGY PRINCIPLES 53](#_Toc71800578)

[WATER MANAGEMENT PRINCIPLES 55](#_Toc71800579)

[CORE UNITS OF LEARNING 59](#_Toc71800580)

[DESIGN OF WATER SUPPLY INFRASTRUTURE 60](#_Toc71800581)

[CONSTRUCTION OF WATER SUPPLY INFRASTRUCTURE 63](#_Toc71800582)

[OPERATION AND MAINTENANCE OF WATER SUPPLY INFRASTRUCTURE 66](#_Toc71800583)

[NON-REVENUE WATER MANAGEMENT 68](#_Toc71800584)

# Abbreviations and ACRONYMS

|  |  |
| --- | --- |
| AP | Arithmetic Progression |
| CAD | Computer Aided Design |
| CBC | Competence Based Curriculum |
| CBETCBR | Competence Based Education and TrainingCalifornia Bearing Ratio |
| CDACC | Curriculum Development, Assessment and Certification Council |
| COD | Chemical Oxygen Demand |
| EMCA | Environmental Management Coordination Act |
| EMS | Environmental Management Systems |
| GHS | Globally Harmonized System |
| GI | Galvanized Iron |
| GIS | Geographical Information Systems |
| GP | Geometric Progression |
| GPSGPRSHDPE | Global Positioning SystemGeneral Packet Radio ServicesHigh-Density Polyethylene |
| ICT | Information Communication Technology |
| 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 |
| NEMANRW | National Environmental Management AuthorityNon- Revenue Water |
| OS | Operating Systems |
| OSH | Occupational Safety and Health |
| PC | Personal Computer |
| PPE | Personal Protective Equipment |
| SMART | Specific, Measurable, Achievable, Results-focused, time-bound |
| SMM | Standard Methods of Measurements |
| SSAC | Sector Skills Advisory Committee |
| TV | Television |
| TVET  | Technical Vocational Education and Training |
| TVETA | Technical Vocational Education and Training Authority |
| UPVC | Unplasticized Polyvinyl Chloride |
| WASPA | Water Service Providers Association |
| WASREB | Water Services Regulatory Board |
| WET | Water Engineering Technology |
| WHO | World Health Organization |
| WHSA | Water Harvesting Storage Authority |
| WSP | Water Service Providers |
| WSTF | Water Services Trust Fund |

# KEY TO UNIT CODE

 **WAT/ CU/ WET/ BC/ 01/ 6/ A**

Industry or sector

Curriculum

Occupational area

Type of Unit

Unit number

Competency level

Version control

# **COURSE OVERVIEW**

Water Engineering Technology level 6 consists of units of learning that an individual must achieve to enable him/her provide water supply services. It entails designing, and constructing water supply infrastructure and operating and maintaining waters supply systems.

The units of Learning comprising Water Engineering Technology Level 6 qualification include the following:

**Basic Units of Learning**

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

**Common Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Duration in Hours** | **Credit Factor** |
| WAT/CU/WET/CC/01/6/A | Water Quality Principles | 60 | 6.0 |
| WAT/CU/WET/CC/02/6/A | Engineering Mathematics | 150 | 15.0 |
| WAT/CU/WET/CC/03/6/A | Workshop Technology | 240 | 24.0 |
| WAT/CU/WET/CC/04/6/A | Applied Physics | 120 | 12.0 |
| WAT/CU/WET/CC/05/6/A | Technical Drawing and Computer Aided Drawing | 240 | 24.0 |
| WAT/CU/WET/CC/06/6/A | Water Technology Principles | 180 | 18.0 |
| WAT/CU/WET/CC/07/6/A | Water Management Principles | 60 | 6.0 |
| **Total**  | **1050** | **105.0** |

**Core Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Duration in Hours** | **Credit Factor** |
| WAT/CU/WET/CR/01/6/A | Design of Water Supply Infrastructure | 600 | 60 |
| WAT/CU/WET/CR/02/6/A | Construction of Water Supply Infrastructure | 300 | 30 |
| WAT/CU/WET/CR/03/6/A | Operation and Maintenance of Water supply Systems | 180 | 18 |
| WAT/CU/WET/CR/04/6/A | Non-Revenue Water Management | 90 | 9.0 |
|  | Industrial attachment | 480 | 48 |
| **Total** | **1170** | **117** |
| **Grand Total** | **3060** | **3060** |

**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. Certificate Water Engineering Craft Certificate, Level 5

**Or**

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

**Trainer qualification**

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

**Industrial Attachment**

An individual enrolled in this course will undergo an industrial attachment for a period of 480 hours in a Water Engineering establishment.

**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 Water Engineering Technology Level 6, an individual must demonstrate competence in all the units of competency in the qualification pack.

These certificates will be awarded by Kenya Water Institute.

# BASIC UNITS OF LEARNING

## COMMUNICATION SKILLS

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

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Communication Skills

**Duration of Unit:** 40 hours

**Unit Description**

This unit covers the competencies required to demonstrate communication skills .It involves, meeting communication needs of clients and colleagues; developing communication strategies, establishing and maintaining communication pathways, conducting interviews, facilitating group discussion and representing the organization.

**Summary of Learning Outcomes**

1. Meet communication needs of clients and colleagues
2. Develop communication strategies
3. Establish and maintain communication pathways
4. Promote use of communication strategies
5. Conduct interview
6. Facilitate group discussion
7. Represent the organization

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. 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
* Types of communication strategies
* Elements of communication strategy
 | * Interview
* Written texts
 |
| 1. Develop communication strategies
 | * Dynamics of groups
* Styles of group leadership
* Openness and flexibility in communication
* Communication skills relevant to client groups
 | * Interview
* Written texts
 |
| 1. Establish and maintain communication pathways
 | * Types of communication pathways
 | * Interview
* Written texts
 |
| 1. Promote use of communication strategies
 | * Application of elements of communication strategies
* Effective communication techniques
 | * Interview
* Written texts
 |
| 1. Conduct interview
 | * Types of interview
* Establishing rapport
* Facilitating resolution of issues
* Developing action plans
 | * Interview
* Written texts
 |
| 1. Facilitate group discussion
 | * Identification of communication needs
* Dynamics of groups
* Styles of group leadership
* Presentation of information
* Encouraging group members participation
* Evaluating group communication strategies
 | * Interview
* Written texts
 |
| 1. Represent the organization
 | * Presentation techniques
* Development of a presentation
* Multi-media utilization in presentation
* Communication skills relevant to client groups
 | * Interview
* Written texts
 |

**Suggested Methods of Instruction**

* Discussion
* Role playing
* Simulation
* Direct instruction

**Recommended Resources**

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

## DIGITAL LITERACY

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

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Digital Literacy

**Duration of Unit:** 60 hours

**Unit Description**

This unit describes competencies required to demonstrate digital literacy. It involves in identifying computer software and hardware, applying security measures to data, hardware, software in automated environment, computer software in solving task, internet and email in communication at workplace, desktop publishing in official assignments 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
 |
| 1. Apply security measures to data, hardware, software in automated environment
 | * 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
* 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
* Project
 |
| 1. Apply internet and email in communication at workplace
 | * Computer networks
* Network configurations
* Uses of internet
* Electronic mail (e-mail) concept
 | * Oral questioning
* 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
* 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
* Written report
* Project
 |

**Suggested Methods of Instruction**

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

**Recommended Resources**

* Computers
* Printers
* Storage devices
* Internet access

## ENTREPRENEURIAL SKILLS

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

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Entrepreneurial Skills

**Duration of unit:** 100 hours

**Unit Description**

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

**Summary of Learning Outcomes**

* 1. Demonstrate understanding of who an entrepreneur
	2. Demonstrate knowledge of entrepreneurship and self-employment
	3. Identify entrepreneurship opportunities
	4. Create entrepreneurial awareness
	5. Apply entrepreneurial motivation
	6. Develop business innovative 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
 |
| 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:** WAT/CU/WET/BC/04/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Employability Skills

**Duration of Unit:** 80 hours

**Unit Description**

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

**Summary of Learning Outcomes**

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

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

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

**Suggested Methods of Instruction**

* Demonstrations
* Simulation/Role play
* Group Discussion
* Presentations
* Assignments
* Q&A

**Recommended Resources**

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

## ENVIRONMENTAL LITERACY

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

**Relationship to Occupational Standards**:

This unit addresses the Unit of Competency : Demonstrate Environmental Literacy

**Duration of Unit:** 40 hours

**Unit Description**

This unit describes the competencies required demonstrate environmental literacy.it involves controlling environmental hazard, controlling 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, monitoring activities on environmental protection/programs, analysing resource use and developing resource conservation plans.

**Summary of Learning Outcomes**

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

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

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

**Suggested Methods of Instruction**

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

**Recommended Resources**

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

## OCCUPATIONAL SAFETY AND HEALTH PRACTICES

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Demonstrate Occupational Safety and Health Practices

**Duration of Unit:** 40 hours

**Unit Description**

This unit specifies the competencies required to demonstrate occupational health and safety practices. It involves identifying workplace hazards and risk, identifying and implementing appropriate control measures to hazards and risks and implementing 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
* Gathering of OSH issues and/or concerns
 | * Oral questions
* Written tests
* Portfolio of evidence
* Third party report
 |
| 1. Control OSH hazards
 | * Prevention and control measures e.g. use of PPE
* Risk assessment
* Contingency measures
 | * Oral questions
* Written tests
* Portfolio of evidence
* Third party report
 |
| 1. Implement OSH

 programs | * Company OSH program, evaluation and review
* Implementation of OSH programs
* 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

##

## WATER QUALITY PRINCIPLES

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

**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 chemistry and biology principles. It involves applying inorganic chemistry principles, organic chemistry principles, physical chemistry principles, water chemistry principles and chemical water quality principles. It also entails applying biology and microbial water quality principles.

This applies in water sector

**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
* Physical and chemical properties of alkanes
* Physical and chemical properties of alkenes and alkynes
* Physical and chemical properties of alcohols
* Physical and chemical properties of carboxylic acids
* 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 Instruction:**

* 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 (10-180oC)
* Incubator
* Muffle furnace (up to 500oC)
* Refrigerator
* Cooler boxes
* Water /steam bath tray
* Wire loop
* Stirring devices for jar tests
* Membrane filtration units
* Thermometers
* Distillers
* filtration units
* Autoclave
 | * Microscope
* Quant tray sealer
* Desiccators
* Hotplates
* Magnetic stirrers
* Computers
* Scientific Calculators
* Relevant reference materials
* Stationeries
* Relevant practical materials
* laboratory
* Internet
* Vacuum Pumps
 |

## ENGINEERING MATHEMATICS

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply engineering mathematics

**Duration of Unit:** 150 hours

**Unit Description**

This unit describes the competencies required 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 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

## WORKSHOP TECHNOLOGY

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply workshop technology

**Duration of Unit:** 240 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 electrical tasks
6. Perform plumbing tasks
7. Perform general welding tasks
8. Perform 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 electrical tasks
 | * Concepts and terminology in electricity and electronics
* Electric charges and current
* Electric and electronic circuits
* Electrical and electronic instruments
* Electrical and electronic measurements
* Errors in electrical measurement
* Ohms law
* Kirchhoff’s laws
* AC and DC circuits in electronic systems
* Electrical and electronic installation
* R-L-C circuits
* Semi-conductor devices
* 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 tasks
 | * Plumbing tools and machinery
* Plumbing 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 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
* 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 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
 | * Observation
* Oral questioning
* Practical tests
* Written
 |

**Suggested Methods of Instruction:**

* 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
 |  |

## APPLIED PHYSICS

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **apply physics principles**

**Duration of unit:** 120 Hours

**Unit Description**

This unit describes the competence required to apply physics principles and techniques. It entails performing measurements of physical quantities and application of mechanics, heat transfer, waves and oscillations, density, pressure, and fluid flow and 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 Interconversion
 | * 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
* Conservation of linear momentum
* Potential energy
* Kinetic energy
* Conservation of energy
* Solving problems
 | * Observation
* Oral questioning
* 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
* Rectilinear 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
* Suction pumps
* Application of pressure in hydraulic machines
 | * Observation
* Oral questioning
* Practical tests
* 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 Instruction:**

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

**Recommended Resources**

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

## TECHNICAL DRAWING AND COMPUTER AIDED DRAWING

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **apply technical drawing and computer aided drawing design principles**

**Duration of Unit:** 240 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 Methods of Instruction:**

* 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/WET/CC/06/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **apply water technology principles**

**Duration of Unit:** 180 Hours

**Unit Description**

This unit describes the competence required to apply water technology principles. It involves applying basic water supply principles, principles of wastewater collection and treatment. It also involves applying basic hydraulics and irrigation and drainage principles.

**Summary of Learning Outcomes**

1. Apply basic water supply principles
2. Apply basic hydraulics principles
3. Apply principles of wastewater collection and treatment
4. Apply basic irrigation and drainage principles

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content**  | **Suggested Assessment Methods** |
| 1. Apply basic 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 basic hydraulic principles
 | * Units of measurements
* Fluid properties and its characteristics
* Fluid pressure and its measurements
* Hydrostatics
* Hydro kinematics
* Hydrodynamics
* Bernoulli’s equation and its applications
* Pipe flow
* Open channel flow
 | * Oral questioning
* Written tests
* Observation
* Practical test
 |
| 1. Apply principles of wastewater collection and treatment
 | * Characteristics of wastewater
* Sources of waste water
* Sewerage systems
* Sewer pipes and appurtenances
* Wastewater Treatment processes and disposal
* Use of waste water for irrigation
 | * Oral questioning
* Written tests
* Observation
* Practical test
 |
| 1. Apply basic irrigation and drainage principles
 | * Soil, plant-water relationship
* Land preparation
* Sources of water for irrigation
* Irrigation farm layout
* Quality of irrigation water
* Irrigation methods
* Methods of drainage
 | * Oral questioning
* Written tests
* Observation
* Practical test
 |

**Suggested Methods of Instruction:**

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

**Recommended Resources**

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

## WATER MANAGEMENT PRINCIPLES

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

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: **Apply water 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, mapping rock 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 integrated water resources management (IWRM) principles.

**Summary of Learning Outcomes**

1. Determine hydrological processes
2. Quantify surface water
3. Map rocks and aquifers
4. Establish well sites
5. Conserve the Environment
6. Develop water harvesting 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. Map rocks and aquifers
 | * Geologic time scale
* Internal structure of the earth
* Earth processes
* Minerals and Rocks
* Aquifers
 | * Written tests
* Interviewing
* Observation
* Third party report
 |
| 1. Establish well sites
 | * Classifications of wells
* Well site establishment
* Well site establishment report
 | * Written tests
* Interviewing
* Observation
* Third party report
 |
| 1. Conserve the Environment
 | * Water conservation
* Soil conservation
* land degradation
 | * Written tests
* Observation
* Interviewing
* Third party report
 |
| 1. Develop water harvesting structures
 | * Water harvesting techniques
* water harvesting structures
* Site selection for water harvesting structures
* Design of simple water harvesting structures
* Operation and maintenance of water harvesting structures
 | * Written tests
* Interviewing
* Observation
* Third party report
 |
| 1. Apply water policy, water and environmental laws, legislation in water resource management, water and sanitation services
 | * Water legislation in Kenya
* Legal and regulatory framework of Water Sector in Kenya:
 | * Written tests
* Observation
* Oral questioning
* Third party report
 |
| 1. Apply Integrated Water Resources Management (IWRM) Principles
 | * Concepts of IWRM
* Principles of IWRM
* Pillars of IWRM:
* Gender mainstreaming in IWRM
* Applications of IWRM in Kenyan Context
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |

**Suggested Methods of Instruction:**

* 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

# CORE UNITS OF LEARNING

## DESIGN OF WATER SUPPLY INFRASTRUTURE

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

**Relationship to Occupational Standards**

This unit addresses the competency: **design water supply infrastructure**

Duration of Unit: 600 Hours

**Unit Description**

This unit covers the competencies required to design water supply infrastructure. It involves conducting feasibility study and site survey for water supply design infrastructure, collecting water supply infrastructure design data, determining water supply infrastructure design data and calculating of water supply infrastructure design parameters. It also entails drawing water supply infrastructure units and preparing water supply infrastructure design reports.

**Summary of Learning Outcomes**

1. Conduct feasibility study
2. Collect site surveying for water supply infrastructure design
3. Collect water supply infrastructure design data
4. Determine water supply infrastructure design parameters
5. Analyse structural elements for water infrastructure
6. Draw water supply infrastructure units
7. Compile water supply infrastructure design report

**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
* Oral questioning
* Third party report
 |
| 1. Conduct site survey for water supply infrastructure design
 | * Site reconnaissance
* Survey tools and equipment
* Site survey
* Survey data analysis and presentation
* GIS and remote sensing for water supply
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Collect water supply infrastructure design data
 | * Water demand
* Population projection
* Cleaning of the collected data
* Basic statistics
* Interpretation of the collected data
* Data management & organization
* Data presentation
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Determine water supply infrastructure design parameters
 | * Design standards and guidelines
* Design materials
* Water storage system design
* Water treatment systems design
* Water conveyance systems design
* Hydraulic structures design
* Drainage system design
* Engineering drawings
* Measurements of works
* Cost estimations
* design report
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Analyse structural elements for water infrastructure
 | * Properties of material
* Moments in beams
* Calculation of Shear forces and bending moments
* Determination of maximum Sheaf forces and Bending moments
* Graphical representations
* Section properties
* Theory of simple bending
* Forces in frames
* Deflection in beams
* Design of Reinforced Concrete Structures
* Design of Timber Structures
* Design of Steel
* Connections (welded)
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Draw water supply infrastructure units
 | * intake structures
* dams & weirs
* pipelines & appurtenances
* treatment plant units
* reservoirs
* water pans
* spring development
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Compile water supply infrastructure design report
 | * Technical report writing
* Legal requirements
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |

**Suggested Methods of Instruction:**

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

**Recommended Resources**

Laboratories

* Soil
* Survey
* Hydrology
* Water quality
* Computer
* Software’s
* Arc-GIS
* Auto CAD

## CONSTRUCTION OF WATER SUPPLY INFRASTRUCTURE

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **construct water supply infrastructure**

**Duration of Unit**: 300 Hours

**Unit Description**

This unit describes the competencies required by a technician in order to analyse soil properties, prepare construction schedule, organize the construction site and construct the water supply infrastructure

**Summary of Learning Outcomes**

1. Analyse soil properties
2. Organize the construction site
3. Prepare construction schedule
4. construct the water supply infrastructure

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Analyse soil properties
 | * Physical properties of soils
* Index properties of soils
* Particle size distribution
* Soil classification and identification
* Compaction of soils
* Field compaction tools and equipment
* Seepage & permeability
* Field methods for determination of soil permeability
* Shear strength
* Vertical Stress Distribution:
* Lateral earth pressure
* Consolidation and settlement
* Stability of slopes
* Bearing capacity
* Site Investigation
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Organize the construction Site
 | * Site layout and organisation
* Resource mobilization
* Contract documents
* Legal requirements
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Prepare construction schedule
 | * Interpretation of working drawings
* Construction activities
* Project planning
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Construct the water supply infrastructure
 | * Site clearance
* Setting out for construction works
* Excavations
* Foundations
* Floors and Walls
* Roofs
* Stairs
* Doors:
* Windows
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |

**Suggested Methods of Instruction:**

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

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Survey equipment
* Construction tools & equipment
* Construction materials
* Laboratories (soils & concrete lab)
* Software application in Construction Management e.g. MS Project

## OPERATION AND MAINTENANCE OF WATER SUPPLY INFRASTRUCTURE

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

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **operate and maintain water supply infrastructure**

**Duration of Unit:**180 hrs

**Unit Description**

This unit covers the competencies required to operate and maintain water supply infrastructure. It involves preparing operation and maintenance schedules, operating water supply system and maintaining water supply systems.

**Summary of Learning Outcomes**

1. Prepare operation and maintenance schedules
2. Operate and maintain water supply system
3. Operate and maintain point of use treatment units
4. Operate and maintain community water supply schemes

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Prepare operation and maintenance schedules
 | * Analysis of tasks
* Preparation of schedules
* Inspection plan
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Operate and maintain water supply system
 | * Operation and maintenance needs
* Optimal operation and maintenance plans
* Resources for operation and maintenance
* Operation and maintenance activities
* Monitoring and evaluation report
* Operation and maintenance report
* Inspection reports
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Operate and maintain point of use treatment units
 | * Particulate filters
* Reverse osmosis
* Ion exchange
* Adsorption filters.
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Operate and maintain community water supply schemes
 | * Springs
* Shallow wells
* Pans
* Sand dams
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |

**Suggested Methods of Instruction:**

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

**Recommended Resources**

* Calculator
* Computers
* Software
* Standard Methods of Measurement
* Civil Engineering Methods of Measurement
* Stationery
* Printers
* Plotters

## NON-REVENUE WATER MANAGEMENT

**UNIT CODE:** WAT/CU/WET/CR/04/6/A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: **manage non-revenue water**

Duration of Unit: 90 hours

**Unit Description**

This unit describes the competencies required by a technician in order to analyse water balance, manage technical (physical) losses, manage commercial losses and manage customer service connections.

**Summary of Learning Outcomes**

1. Analyse water balance
2. Manage technical losses (physical losses)
3. Manage commercial losses
4. Manage customer service connections

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Analyse water balance
 | * Basic principles of non-revenue water
* Challenges facing non-revenue water management
* Components of water balance
* Computation of water balance
* Stages of water balance computation
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Manage technical losses (physical losses)
 | * Causes of physical losses
* Leak detection tools & equipment
* Leak repairs
* Estimation of physical losses
* Loss reduction techniques
* Zoning of water supply system
* Mapping of the water supply system
* Pressure management in water distribution system
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Manage commercial losses
 | * Causes of commercial losses
* Metering
* Billing
* Tariff setting
* Customer data management
* Mapping points of commercial losses
* Employ emerging technologies
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |
| 1. Manage customer service connections
 | * Mapping of customer connections
* Route selection
* Estimating connection materials required
* Cost estimations
* Connection schedule procedure
* Connection activities
* Tapping
* Connection materials
* Installation conditions
* Meter placement & sizing
* Meter testing and servicing
* Disconnection and reconnection policy and practice
* Meter protection
 | * Written tests
* Observation
* Interviewing
* Oral questioning
* Third party report
 |

**Suggested Methods of Instruction:**

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

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Leak detection equipment
* Internet
* Flow meters
* Smart meters