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**THE REPUBLIC OF KENYA**

**NATIONAL OCCUPATIONAL STANDARDS**

**FOR**

**IRRIGATION AND DRAINAGE ENGINEERING TECHNICIAN**

**LEVEL 6**

|  |  |
| --- | --- |
|  |  |
| KENYA WATER INSTITUTEP.O. BOX 60013-00200NAIROBI | TVET CDACCP.O. BOX 15745-00100NAIROBI |

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**DIRECTOR**

**KENYA WATER INSTITUTE**

**P.O. BOX 60013 - 00200**

**NAIROBI**

**Email: info@kewi.or.ke**

# 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 these Occupational Standards were developed for the purpose of developing a competency-based curriculum for Irrigation and Drainage Engineering Technicians. These Occupational Standards will also be the basis for assessment of an individual for competence certification.

It is my conviction that these Occupational Standards 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 labor 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 these occupational standards. These occupational standards will be the basis for development of competency-based curriculum for Irrigation and Drainage Technology, KNQF Level 6. These Standards will also be the basis for assessment of an individual for competence certification.

The occupational standards are designed and organized with clear performance criteria for each element and unit of competency. These standards also outline the required knowledge and skills as well as evidence guide.

I am grateful to the KEWI Academic Board, Technical Teams, TVET CDACC, and Water Management SSAC, Experts drawn from Universities and Water Sector Institutions and all other stakeholders who participated in the development of these occupational standards.

**CHAIRPERSON,**

**KENYA WATER INSTITUTE GOVERNING COUNCIL**

# ACKNOWLEDGMENT

These Occupational Standards were developed through combined effort of various stakeholders from private and public organizations. I am sincerely thankful to the management of these organizations for allowing their staff to participate in this course. I wish to acknowledge the invaluable contribution of industry players who provided inputs towards the development of these Standards.

I thank TVET Curriculum Development, Assessment and Certification Council (TVET CDACC) for providing guidance on the development of these Standards. My gratitude goes to National Irrigation Board (NIB), Jomo Kenyatta University of Agriculture (JKUAT) and University of Nairobi (UoN) and Water Sector Skills Advisory Committee (SSAC) members for their contribution to the development of these Standards. I thank all the individuals and organizations who participated in the validation of these Standards.

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 these standards.

I acknowledge all institutions which in one way or another contributed to the success of development of these Standards.

**CEO/COUNCIL SECRETARY**

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

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# ACRONYMS

|  |  |
| --- | --- |
| AC | Alternating Current |
| 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 |
| IDET | Irrigation and Drainage Engineering Technology |
| EMCA | Environmental Management Coordination Act |
| FAO | Food and Agriculture Organization |
| EMS | Environmental Management Systems |
| 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 |
| NIB | National Irrigation Board |
| NEMA | National Environmental Management Authority |
| OS | Operating Systems |
| OSH | Occupational Safety and Health |
| PC | Personal Computer |
| PE | Polyethylene |
| PPE | Personal Protective Equipment |
| PP | Polypropylene |
| PV | Photovoltaic |
| PVC | Polyvinylchloride |
| 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 Fun |

# 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

# OVERVIEW

Irrigation and Drainage Engineering Technicians occupational standards 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 competency comprising Irrigation and Drainage Engineering Technician Level 6 occupational standards include the following:

**Basic Units of Competency**

|  |  |
| --- | --- |
| **Unit Code** | **Unit Title** |
| WAT/OS/IDET/BC/01/6/A | Demonstrate Communication Skills |
| WAT/OS/IDET/BC/02/6/A | Demonstrate Digital Literacy |
| WAT/OS/IDET/BC/03/6/A | Demonstrate Entrepreneurial Skills |
| WAT/OS/IDET/BC/04/6/A | Demonstrate Employability Skills |
| WAT/OS/IDET/BC/05/6/A | Demonstrate Environmental Literacy |
| WAT/OS/IDET/BC/06/6/A | Demonstrate Occupational Safety and Health Practices |

**Common Units of Competency**

|  |  |
| --- | --- |
| Unit Code | Unit Title |
| WAT/OS/IDET/CC/01/6/A | Apply Water quality Principles |
| WAT/OS/IDET/CC/02/6/A | Apply Physics principles |
| WAT/OS/IDET/CC/03/6/A | Apply Engineering Mathematics  |
| WAT/OS/IDET/CC/04/6/A | Apply Electrical and Mechanical Techniques  |
| WAT/OS/IDET/CC/05/6/A | Apply Workshop Technology |
| WAT/OS/IDET/CC/06/6/A | Apply Technical Drawings and Computer Aided Design Principles |
| WAT/OS/IDET/CC/07/6/A | Apply Water Technology Principles |
| WAT/OS/IDET/CC/08/6/A | Apply Water Resources Management Principles |
| WAT/OS/IDET/CC/09/6/A | Apply Soil and Crop Science |
| WAT/OS/IDET/CC/10/6/A | Apply Principles of Fluid, Soil and Structural Mechanics |

**Core Units of Competency**

|  |  |
| --- | --- |
| Unit Code | Unit Title |
| WAT/OS/IDET/CR/01/6/A | Design Irrigation and Drainage Infrastructure |
| WAT/OS/IDET/CR/02/6/A | Construct Irrigation and Drainage Infrastructure |
| WAT/OS/IDET/CR/03/6/A | Operate and Maintain Irrigation and Drainage Systems |

# BASIC UNITS OF COMPETENCY

# DEMONSTRATE COMMUNICATION SKILLS

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

**UNIT DESCRIPTION**

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

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT** These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Meet communication needs of clients and colleagues
 | 1.1 Specific communication needs of clients and colleagues are identified and met1.2 Different approaches are used to meet communication needs of clients and colleagues1.3 Conflict is addressed promptly and in a timely way and in a manner, which does not compromise the standing of the organization |
| 1. Develop communication strategies
 | * 1. Strategies for effective internal and external dissemination of information are developed to meet the organization’s requirements
	2. Special communication needs are considered in developing strategies to avoid discrimination in the workplace
	3. Communication ***strategies*** are analyzed, evaluated and revised where necessary to make sure they are effective
 |
| 1. Establish and maintain communication pathways
 | * 1. Pathways of communication are established to meet requirements of organization and workforce
	2. Pathways are maintained and reviewed to ensure personnel are informed of relevant information
 |
| 1. Promote use of communication strategies
 | * 1. Information is provided to all areas of the organization to facilitate implementation of the strategy
	2. Effective communication techniques are articulated and modelled to the workforce
	3. Personnel are given guidance about adapting communication strategies to suit a range of contexts
 |
| 1. Conduct interview
 | 1. A range of appropriate communication strategies are employed in ***interview situations***
2. Records of interviews are made and maintained in accordance with organizational procedures
3. Effective questioning, listening and nonverbal communication techniques are used to ensure that required message is communicated
 |
| 1. Facilitate group discussion
 | * 1. Mechanisms which enhance ***effective group interaction*** is defined and implemented
	2. Strategies which encourage all group members to participate are used routinely
	3. Objectives and agenda for meetings and discussions are routinely set and followed
	4. Relevant information is provided to group to facilitate outcomes
	5. Evaluation of group communication strategies is undertaken to promote participation of all parties
	6. Specific communication needs of individuals are identified and addressed
 |
| 1. Represent the organization
 | 7.1 When participating in internal or external forums, presentation is relevant, appropriately researched and presented in a manner to promote the organization 7.2 Presentation is clear and sequential and delivered within a predetermined time 7.3 Appropriate media is utilized to enhance presentation 7.4 Differences in views are respected7.5 Written communication is consistent with organizational standards 7.6 Inquiries are responded in a manner consistent with organizational standard |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| * Communication strategies
* include but not limited to:
 | * Language switch
* Comprehension check
* Repetition
* Asking confirmation
* Paraphrase
* Clarification request
* Translation
* Restructuring
* Approximation
* Generalization
 |
| * Effective group interaction includes but not limited to:
 | * Identifying and evaluating what is occurring within an interaction in a nonjudgmental way
* Using active listening
* Making decision about appropriate words, behavior
* Putting together response which is culturally appropriate
* Expressing an individual perspective
* Expressing own philosophy, ideology and background and exploring impact with relevance to communication
 |
| * Situations include but not limited to:
 | * Establishing rapport
* Eliciting facts and information
* Facilitating resolution of issues
* Developing action plans
* Diffusing potentially difficult situations
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Effective communication
* Active listening
* Giving/receiving feedback
* Interpretation of information
* Role boundaries setting
* Negotiation
* Establishing empathy
* Openness and flexibility in communication
* Communication skills required to fulfill job roles as specified by the organization
* Writing communications strategy
* Applying key elements of communications strategy

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Communication process
* Dynamics of groups and different styles of group leadership
* Communication skills relevant to client groups
* Flexibility in communication
* Communication skills relevant to client groups
* Key elements of communications strategy

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency
 | Assessment requires evidence that the candidate: 1. Developed communication strategies to meet the organization requirements and applied in the workplace
2. Established and maintained communication pathways for effective communication in the workplace
3. Used communication strategies involving exchanges of complex oral information
 |
| 1. Resource Implications
 | The following resources should be provided: 1. Access to relevant workplace or appropriately simulated environment where assessment can take place
2. Materials relevant to the proposed activity or tasks
 |
| 1. Methods of Assessment
 | Competency in this unit may be assessed through: 1. Direct Observation/Demonstration with Oral Questioning
2. Written Examination
 |
| 1. Context of Assessment
 | Competency may be assessed individually in the actual workplace or through accredited institution |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## DEMONSTRATE DIGITAL LITERACY

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

**UNIT DESCRIPTION**

This unit covers the competencies required to effectively use digital devices such as smartphones, tablets, laptops and desktop PCs. It entails identifying and using digital devices such as smartphones, tablets, laptops and desktop PCs for purposes of communication, work performance and management at the work place.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT** These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Identify appropriate computer software and hardware
 | * 1. Concepts of ICT are determined in accordance with computer equipment
	2. Classifications of computers are determined in accordance with manufacturers specification
	3. ***Appropriate computer software*** is identified according to manufacturer’s specification
	4. ***Appropriate computer hardware*** is identified according to manufacturer’s specification
	5. Functions and commands of operating system are determined in accordance with manufacturer’s specification
 |
| 1. Apply security measures to data, hardware, software in automated environment
 | * 1. ***Data security and privacy are classified*** in accordance with the prevailing technology
	2. ***Security threats*** reidentified ***and control measures*** are applied in accordance with laws governing protection of ICT
	3. Computer threats and crimes are detected.
	4. Protection against computer crimes is undertaken in accordance with laws governing protection of ICT
 |
| 1. Apply computer software in solving tasks
 | * 1. ***Word processing concepts*** are applied in resolving workplace tasks, report writing and documentation
	2. ***Word processing utilities*** are applied in accordance with workplace procedures
	3. Worksheet layout is prepared in accordance with work procedures
	4. Worksheet is build and data manipulated in the worksheet in accordance with workplace procedures
	5. Continuous data manipulated on worksheet is undertaken in accordance with work requirements
	6. Database design and manipulation is undertaken in accordance with office procedures
	7. Data sorting, indexing, storage, retrieval and security is provided in accordance with workplace procedures
 |
| 1. Apply internet and email in communication at workplace
 | * 1. Electronic mail addresses are opened and applied in workplace communication in accordance with office policy
	2. Office internet functions are defined and executed in accordance with office procedures
	3. ***Network configuration*** is determined in accordance with office operations procedures
	4. Official World Wide Web is installed and managed according to workplace procedures
 |
| 1. Apply Desktop publishing in official assignments
 | * 1. Desktop publishing functions and tools are identified in accordance with manufactures specifications
	2. Desktop publishing tools are developed in accordance with work requirements
	3. Desktop publishing tools are applied in accordance with workplace requirements
	4. Typeset work is enhanced in accordance with workplace standards
 |
| 1. Prepare presentation packages
 | * 1. Types of presentation packages are identified in accordance with office requirements
	2. Slides are created and formulated in accordance with workplace procedures
	3. Slides are edited and run in accordance with work procedures
	4. Slides and handouts are printed according to work requirements
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| * Appropriate computer software may include but not limited to:
 | * A collection of instructions or computer tools that enable the user to interact with a computer, its hardware, or perform tasks.
 |
| * Appropriate computer hardware may include but not limited to:
 | Collection of physical parts of a computer system such as;* Computer case, monitor, keyboard, and mouse
* All the parts inside the computer case, such as the hard disk drive, motherboard and video card
 |
| * Data security and privacy may include but not limited to:
 | * Confidentiality of data
* Cloud computing
* Integrity -but-curious data surfing
 |
| * Security and control measures may include but not limited to:
 | * Counter measures against cyber terrorism
* Risk reduction
* Cyber threat issues
* Risk management
* Pass-wording
 |
| * Security threats may include but not limited to:
 | * Cyber terrorism
* Hacking
 |
| * Word processing concepts may include but not limited to:
 | * Using a special program to create, edit and print documents
 |
| * Network configuration may include but not limited to:
 | * Organizing and maintaining information on the components of a computer network
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Analytical skills
* Interpretation
* Typing
* Communication
* Computing (applying fundamental operations such as addition, subtraction, division and multiplication)
* Using calculator
* Basic ICT skills

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Software concept
* Functions of computer software and hardware
* Data security and privacy
* Computer security threats and control measures
* Technology underlying cyber-attacks and networks
* Cyber terrorism
* Computer crimes
* Detection and protection of computer crimes
* Laws governing protection of ICT
* Word processing;
* Functions and concepts of word processing.
* Documents and tables creation and manipulations
* Mail merging
* Word processing utilities
* Spread sheets;
* Meaning, formulae, function and charts, uses and layout
* Data formulation, manipulation and application to cells
* Database;
* Database design, data manipulation, sorting, indexing, storage retrieval and security
* Desktop publishing;
* Designing and developing desktop publishing tools
* Manipulation of desktop publishing tools
* Enhancement of typeset work and printing documents
* Presentation Packages;
* Types of presentation Packages
* Creating, formulating, running, editing, printing and presenting slides and handouts
* Networking and Internet;
* Computer networking and internet.
* Electronic mail and world wide web
* Emerging trends and issues in ICT;
* Identify and integrate emerging trends and issues in ICT
* Challenges posed by emerging trends and issues

**EVIDENCE** **GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Identified and controlled security threats
	2. Detected and protected computer crimes
	3. Applied word processing in office tasks
	4. Designed, prepared work sheet and applied data to the cells in accordance to workplace procedures
	5. Opened electronic mail for office communication as per workplace procedure
	6. Installed internet and World Wide Web for office tasks in accordance with office procedures
	7. Integrated emerging issues in computer ICT applications
	8. Applied laws governing protection of ICT
 |
| 1. Resource Implications
 | * 1. Tablets
	2. Laptops and
	3. Desktop PCs
	4. Desktop computer
	5. Lap top
	6. Calculator
	7. Internet
	8. Smart phone
	9. Operations Manuals
 |
| 1. Methods of Assessment
 | Competency may be assessed through:* 1. Written Test
	2. Demonstration
	3. Practical assignment
	4. Interview/Oral Questioning
	5. Demonstration
 |
| 1. Context of Assessment
 | Competency may be assessed in an off and on the job setting |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## DEMONSTRATE UNDERSTANDING OF ENTREPRENEURSHIP

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

**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.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA** These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| --- | --- |
| 1. Demonstrate understanding of an Entrepreneur
 | * 1. Entrepreneurs and Business persons are distinguished as per ***principles of entrepreneurship***
	2. ***Types of entrepreneurs*** are identified as per principles of entrepreneurship
	3. Ways of becoming an Entrepreneur are identified as per principles of Entrepreneurship
	4. ***Characteristics of Entrepreneurs*** are identified as per principles of Entrepreneurship
	5. Factors affecting Entrepreneurship development are explored as per principles of Entrepreneurship
 |
| 1. Demonstrate understanding of Entrepreneurship and self-employment
 | 1. Entrepreneurship and self-employment are distinguished as per principles of entrepreneurship
2. Importance of self-employment is analysed based on business procedures and strategies
3. ***Requirements for entry into self-employment*** are identified according to business procedures and strategies
4. Role of an Entrepreneur in business is determined according to business procedures and strategies
5. Contributions of Entrepreneurs to National development are identified as per business procedures and strategies
6. Entrepreneurship culture in Kenya is explored as per business procedures and strategies
7. Born or made Entrepreneurs are distinguished as per entrepreneurial traits
 |
| 1. Identify Entrepreneurship opportunities
 | 1. Sources of business ideas are identified as per business procedures and strategies
2. ***Business ideas*** and opportunities are generated as per business procedures and strategies
3. Business life cycle is analysed as per business procedures and strategies
4. Legal aspects of business are identified as per procedures and strategies
5. Product demand is assessed as per market strategies
6. Types of ***business environment*** are identified and evaluated as per business procedures
7. Factors to consider when evaluating business environment are explored based on business procedure and strategies
8. Technology in business is incorporated as per best practice
 |
| 1. Create entrepreneurial awareness
 | 1. ***Forms of businesses*** are explored as per business procedures and strategies
2. Sources of business finance are identified as per business procedures and strategies
3. Factors in selecting source of business finance are identified as per business procedures and strategies
4. ***Governing policies*** on Small Scale Enterprises (SSEs) are determined as per business procedures and strategies
5. Problems of starting and operating SSEs are explored as per business procedures and strategies
 |
| 1. Apply entrepreneurial motivation
 | 1. ***Internal and external motivation*** factors are determined in accordance with ***motivational theories***
2. Self-assessment is carried out as per ***entrepreneurial orientation***
3. Effective communications are carried out in accordance with ***communication principles***
4. Entrepreneurial motivation is applied as per motivational theories
 |
| 1. Develop innovative business strategies
 | 1. Business innovation strategies are determined in accordance with the organization strategies
2. Creativity in business development is demonstrated in accordance with business strategies
3. ***Innovative business strategies*** are developed as per business principles
4. Linkages with other entrepreneurs are created as per best practice
5. ICT is incorporated in business growth and development as per best practice
 |
| 1. Develop Business Plan
 | 1. Identified Business is described as per business procedures and strategies
2. Marketing plan is developed as per business plan format
3. Organizational/Management plan is prepared in accordance with business plan format
4. Production/operation plan in accordance with business plan format
5. Financial plan is prepared in accordance with the business plan format
6. Executive summary is prepared in accordance with business plan format
7. Business plan is presented as per best practice
 |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

| **Variable** | **Range** include but not limited to: |
| --- | --- |
| * Types of entrepreneurs but not limited to:
 | * Innovators
* Imitators
* Craft
* Opportunistic
* Speculators
 |
| * Principles of Entrepreneurship but not limited to:
 | * Visionary
* Solution provider
* Accountability
* Growth and marketing
* Resilient
* Tenacious
 |
| * Characteristics of Entrepreneurs include but not limited to:
 | * Creative
* Innovative
* Planner
* Risk taker
* Networker
* Confident
* Flexible
* Persistent
* Patient
* Independent
* Future oriented
* Goal oriented
 |
| * Requirements for entry into self-employment
 | * Technical skills
* Management skills
* Entrepreneurial skills
* Resources
* Infrastructure
 |
| * Internal motivation
 | * Interest
* Passion
* Freedom
* Prestige
 |
| * Business environment
 | * External
* Internal
* Intermediate
 |
| * Forms of businesses
 | * Sole proprietorship
* Partnership
* Limited companies
* Cooperatives
 |
| * Governing policies
 | * Increasing scope for finance
* Promoting cooperation between entrepreneurs and private sector
* Reducing regulatory burden on entrepreneurs
* Developing IT tools for entrepreneurs
 |
| * External motivation
 | * Rewards
* Punishment
* Enabling environment
* Government policies
 |
| * Entrepreneurial orientation
 | * Passion
* Interest
* Hobbies
* Skills
 |
| * Innovative business strategies
 | * New products
* New methods of production
* New markets
* New sources of supplies
* Change in industrialization
 |
| * Communication principles
 | * Feed back
* Attention
* Clarity
* Timeliness
* Adequacy
* Consistency
* Informality
 |
| * Motivational theories include but not limited to:
 | * Marslows theory
* McClelland theory
* Fredrick Tylors theory
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Assessing a range of alternative products and strategies
* Critically analyzing information, summarizing and making sense of previous and current market trends
* Identifying changing consumer preferences and demographics
* Thinking “outside the box”
* Ensuring quality consistency
* Reducing lead time to product/service delivery
* Management
* Using formal problem-solving procedures, e. g., root-cause analysis, six sigmas
* Communication
* Applying motivational principles, e. g., positive stroking, behavior modification
* Assessing range of alternatives rather than choosing the easiest option
* Achieving ownership and credibility for the enterprise vision
* Critically analyzing information, summarizing and making sense of previous and current market trends
* Developing solutions and practical strategies which are “outside the box”

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Entrepreneurial competencies
* Decision making
* Business communication
* Change management
* Coping with competition
* Risk taking
* Net working
* Time management
* Leadership
* Factors affecting entrepreneurship development
* Principles of Entrepreneurship
* Features and benefits of common operational practices, e. g., continuous improvement (kaizen), waste elimination,
* Conflict resolution
* Health, safety and environment (HSE) principles and requirements
* Customer care strategies
* Basic financial management
* Business strategic planning
* Impact of change on individuals, groups and industries
* Government and regulatory processes
* Local and international market trends
* Product promotion strategies
* Market and feasibility studies
* Government and regulatory processes
* Local and international business environment
* Concepts of change management
* Relevant developments in other industries
* Regional/ County business expansion strategies
* Innovation in business

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:1. Distinguished entrepreneurs and business persons correctly
2. Identified ways of becoming an entrepreneur appropriately
3. Explored factors affecting entrepreneurship development appropriately
4. Analysed importance of self-employment accurately
5. Identified requirements for entry into self-employment correctly
6. Identified sources of business ideas correctly
7. GeneratedBusiness ideas and opportunities correctly
8. Analysed business life cycle accurately
9. Identified legal aspects of business correctly
10. Assessed product demand accurately
11. Determined Internal and external motivation factors appropriately
12. Carried out communications effectively
13. Identified sources of business finance correctly
14. Determined Governing policy on small scale enterprise appropriately
15. Explored problems of starting and operating SSEs effectively
16. Developed Marketing, Organizational/Management, Production/Operation and Financial plans correctly
17. Prepared executive summary correctly
18. Determined business innovative strategies appropriately
19. Presented business plan effectively
 |
| 1. Resource Implications
 | The following resources should be provided:1. Check list
2. Research tools (Questionnaire, interview guide, observation schedule)
3. Materials, tools, equipment and machines relevant
 |
| 1. Methods of Assessment
 | 1. Written tests
2. Observation
3. Oral questions
4. Third party report
5. Interviews
6. Case problems
7. Portfolio
 |
| 1. Context of Assessment
 | 1. Competency may be assessed in workplace or in a simulated workplace setting
2. Assessment shall be observed while tasks are being undertaken whether individually or in-group
 |
| 5. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## DEMONSTRATE EMPLOYABILITY SKILLS

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

**UNIT DESCRIPTON**

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.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Conduct self-management
 | 1. Personal vision, mission and goals are formulated based on potential and in relation to organization objectives
2. Emotions are managed as per workplace requirements
3. Individual performance is evaluated and monitored according to the agreed targets.
4. Assertiveness is developed and maintained based on the requirements of the job.
5. Accountability and responsibility for own actions are demonstrated.
6. Self-esteem and a positive self-image are developed and maintained.
7. Time management, attendance and punctuality are observed as per the organization policy.
8. Goals are managed as per the organization’s objective
9. Self-strengths and weaknesses are identified as per ***personal objectives***
10. Critics are managed as per personal objectives
 |
| 1. Demonstrate interpersonal communication
 | 1. Listening and understanding is demonstrated as per communication policy
2. Writing to the needs of the audience is demonstrated as per communication policy
3. Speaking, reading and writing is demonstrated as per communication policy
4. Negotiation skills are demonstrated as per communication policy
5. Empathizing is demonstrated as per the communication policy
6. Numeracy is applied as per the communication policy
7. Internal and external customers’ needs are identified and interpreted as per the communication policy
8. Persuasion is demonstrated as per the communication policy
9. Communication networks are established as per the SOPs
10. Information is shared as per communication structure
 |
| 1. Demonstrate critical safe work habits
 | * 1. Stress is managed in accordance with workplace procedures.
	2. Punctuality and time consciousness is demonstrated in line with workplace policy.
	3. Personal objectives are integrated with organization goals based on organization’s strategic plan.
	4. ***Resources*** are utilized in accordance with workplace policy.
	5. Work priorities are set in accordance to workplace procedures.
	6. Leisure time is recognized in line with organization policy.
	7. Abstinence from ***drug and substance abuse*** is observed as per workplace policy.
	8. Awareness of HIV and AIDS is demonstrated in line with workplace requirements.
	9. Safety consciousness is demonstrated in the workplace based on organization safety policy.
	10. ***Emerging issues*** are dealt with in accordance with organization policy.
 |
| 1. Lead a workplace team
 | 1. Performance expectations for the ***team*** are set
2. Duties and responsibilities are assigned in accordance with the organization policy.
3. Team parameters and ***relationships*** are identified according to set rules and regulations.
4. ***Forms of communication*** in a team are established according to office policy.
5. Communication is carried out as per workplace place policy and requirements of the job.
6. Team performance is supervised
7. ***Feedback*** on performance is collected and analyzed based on established team learning process
8. Conflicts are resolved between team members in line with organization rules and regulations.
9. ***Gender mainstreaming*** is undertaken in accordance with set regulations.
10. Human rights are adhered to in accordance with existing protocol.
11. Healthy relationships are developed and maintained for harmonious co-existence in line with workplace.
 |
| 1. Plan and organize work
 | 1. Task requirements are identified as per the workplace objectives
2. Task is interpreted in accordance with safety (OHS ), environmental requirements and quality requirements
3. Work activity is organized with other involved personnel as per the SOPs
4. Resources are mobilized, allocated and utilized to meet project goals and deliverables.
5. Work activities are monitored and evaluated in line with organization procedures.
6. Job planning is documented in accordance with workplace requirements.
7. Planning and organizing of work activities is reviewed as per the workplace requirements
8. Time is managed achieve workplace set goals and objectives.
 |
| 1. Maintain professional growth and development
 | * 1. Personal training needs are identified and assessed in line with the requirements of the job.
	2. ***Training and career opportunities*** are identified and availed based on job requirements.
	3. Resources for training are mobilized and allocated based organizations skills needs.
	4. Licensees and certifications relevant to job and career are obtained and renewed.
	5. ***Personal growth*** is pursued towards improving the qualifications set for the profession.
	6. Work priorities and commitments are managed based on requirement of the job and workplace policy.
	7. Recognitions are sought as proof of career advancement in line with professional requirements.
 |
| 1. Demonstrate workplace learning
 | * 1. Own learning is managed as per workplace policy.
	2. Learning opportunities are sought and allocated based on job requirement and in line with organization policy.
	3. Contribution to the learning community at the workplace is carried out.
	4. ***Range of media for learning*** are established as per the training need
	5. Application of learning is demonstrated in both technical and non-technical aspects based on requirements of the job
	6. Enthusiasm for ongoing learning is demonstrated
	7. Time and effort is invested in learning new skills-based job requirements
	8. Willingness to learn in different context is demonstrated based on available learning opportunities arising in the workplace.
	9. Awareness of Occupational Health and Safety procedures are demonstrated in use of technology in the workplace.
	10. Initiative is taken to create more effective and efficient processes and procedures in line with workplace policy.
	11. New systems are developed and maintained in accordance with the requirements of the job.
	12. Opportunities that are not obvious are identified and exploited in line with organization objectives.
	13. Opportunities for performance improvement are identified proactively in area of work.
	14. Awareness of personal role in workplace ***innovation*** is demonstrated.
 |
| 1. Demonstrate problem solving skills
 | * 1. Creative, innovative and practical solutions are developed based on the problem
	2. Independence and initiative in identifying and solving problems is demonstrated.
	3. Team problems are solved as per the workplace guidelines
	4. Problem solving strategies are applied as per the workplace guidelines
	5. Problems are analyzed and assumptions tested as per the context of data and circumstances
 |
| 1. Manage workplace ethics
 | * 1. Policies and guidelines are observed as per the workplace requirements
	2. Self-worth and profession is exercised in line with personal goals and organizational policies
	3. Code of conduct is observed as per the workplace requirements
	4. Personal and professional integrity is demonstrated as per the personal goals
	5. Commitment to jurisdictional laws is demonstrated as per the workplace requirements
 |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| Variable | **Range** |
| * Drug and substance abuse include but not limited to:
 | Commonly abused* Alcohol
* Tobacco
* Miraa
* Over-the-counter drugs
* Cocaine
* Bhang
* Glue
 |
| * Feedback includes but not limited to:
 | * Verbal
* Written
* Informal
* Formal
 |
| * Relationships includes but not limited to:
 | * Man/Woman
* Trainer/trainee
* Employee/employer
* Client/service provider
* Husband/wife
* Boy/girl
* Parent/child
* Sibling relationships
 |
| * Forms of communication include but not limited to:
 | * Written
* Visual
* Verbal
* Non verbal
* Formal and informal
 |
| * Team includes but not limited to:
 | * Small work group
* Staff in a section/department
* Inter-agency group
 |
| * Personal growth includes but not limited to:
 |

|  |
| --- |
| * Growth in the job
* Career mobility
* Gains and exposure the job gives
* Net workings
* Benefits that accrue to the individual as a result of noteworthy performance
 |

 |
| * Personal objectives include but not limited to:
 | * Long term
* Short term
* Broad
* Specific
 |
| * Trainings and career opportunities includes but not limited to
 | * Participation in training programs
* Technical
* Supervisory
* Managerial
* Continuing Education
* Serving as Resource Persons in conferences and workshops
 |
| * Resource include but not limited to:
 | * Human
* Financial
* Technology
* Hardware
* Software
 |
| * Innovation include but not limited to:
 | * New ideas
* Original ideas
* Different ideas
* Methods/procedures
* Processes
* New tools
 |
| * Emerging issues include but not limited to:
 | * Terrorism
* Social media
* National cohesion
* Open offices
 |
| * Range of media for learning include but not limited to:
 | * Mentoring
* peer support and networking
* IT and courses
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Personal hygiene practices
* Intra and Interpersonal skills
* Communication skills
* Knowledge management
* Interpersonal skills
* Critical thinking skills
* Observation skills
* Organizing skills
* Negotiation skills
* Monitoring skills
* Evaluation skills
* Record keeping skills
* Problem solving skills
* Decision Making skills
* Resource utilization skills
* Resource mobilization skills

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Work values and ethics
* Company policies
* Company operations, procedures and standards
* Occupational Health and safety procedures
* Fundamental rights at work
* Personal hygiene practices
* Workplace communication
* Concept of time
* Time management
* Decision making
* Types of resources
* Work planning
* Resources and allocating resources
* Organizing work
* Monitoring and evaluation
* Record keeping
* Workplace problems and how to deal with them
* Negotiation
* Assertiveness
* Team work
* Gender mainstreaming
* HIV and AIDS
* Drug and substance abuse
* Leadership
* Safe work habits
* Professional growth and development
* Technology in the workplace
* Learning
* Creativity
* Innovation
* Emerging issues
	+ Social media
	+ Terrorism
	+ National cohesion

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Conducted self-management
	2. Demonstrated interpersonal communication
	3. Demonstrated critical safe work habits
	4. Demonstrated the ability to lead a workplace team
	5. Planned and organized work
	6. Maintained professional growth and development
	7. Demonstrated workplace learning
	8. Demonstrated problem solving skills
	9. Demonstrated the ability to manage ethical performance
 |
| 1. Resource Implications
 |

|  |
| --- |
| The following resources should be provided:  |

* 1. Case studies/scenarios
 |
| 1. Methods of Assessment
 | Competency in this unit may be assessed through: 1. Oral Interview
2. Observation
3. Third Party Reports
4. Written
 |
| 1. Context of Assessment
 | * 1. Competency may be assessed in workplace or in a simulated workplace setting
	2. Assessment shall be observed while tasks are being undertaken whether individually or in-group
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## DEMONSTRATE ENVIRONMENTAL LITERACY

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

**UNIT DESCRIPTION**

This unit specifies the competencies required to follow procedures for environmental hazard control, follow procedures for environmental pollution control, comply with workplace sustainable resource use, evaluate current practices in relation to resource usage, develop and adhere to environmental protection principles/strategies/guidelines, analyze resource use, develop resource conservation plans and implement selected plans.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Control environmental hazard
 | 1.1 ***Storage methods*** for environmentally hazardous materials are strictly followed according to environmental regulations and OSHS. 1.2 ***Disposal methods*** of hazardous wastes are followed at all times according to environmental regulations and OSHS.1.3 ***PPE*** is used according to OSHS.  |
| 1. Control environmental Pollution control
 | * 1. Environmental pollution ***control measures*** are compiled following standard protocol.
	2. Procedures for solid waste management are observed according Environmental Management and Coordination Act 1999
	3. Methods for minimizing ***noise pollution*** complied following environmental regulations.
 |
| 1. Demonstrate sustainable resource use
 | * 1. Methods for minimizing wastage are complied with.
	2. Waste management procedures are employed following principles of 3Rs (Reduce, Reuse, Recycle)
	3. Methods for economizing or reducing resource consumption are practiced.
 |
| 1. Evaluate current practices in relation to resource usage
 | * 1. Information on resource efficiency systems and procedures are collected and provided to the work group where appropriate.
	2. Current resource usage is measured and recorded by members of the work group.
	3. Current purchasing strategies are analyzed and recorded according to industry procedures.
	4. Current work processes to access information and data is analyzed following enterprise protocol.
 |
| 1. Identify Environmental legislations/conventions for environmental concerns
 | 5.1 Environmental legislations/conventions and local ordinances are identified according to the different environmental aspects/impact5.2 Industrial standard/environmental practices are described according to the different environmental concerns |
| 1. Implement specific environmental programs
 | 6.1 Programs/Activities are identified according to organizations policies and guidelines.6.2 Individual roles/responsibilities are determined and performed based on the activities identified.6.3 Problems/constraints encountered are resolved in accordance with organizations’ policies and guidelines6.4 Stakeholders are consulted based on company guidelines |
| 1. Monitor activities on Environmental protection/Programs
 | 7.1 Activities are periodically monitored and Evaluated according to the objectives of the environmental program7.2 Feedback from stakeholders are gathered and considered in Proposing enhancements to the program based on consultations7.3 Data gathered are analyzed based on Evaluation requirements7.4 Recommendations are submitted based on the findings7.5 Management support systems are set/established to sustain and enhance the program7.6 Environmental incidents are monitored and reported to concerned/proper authorities |
| 1. Analyze resource use
 | 8.1. All resource consuming processes are Identified8.2. Quantity and nature of Resource consumed is determined8.3. Resource flow is analyzed through different parts of the process.8.4. Wastes are classified for possible source of resources. |
| 1. Develop resource Conservation plans
 | 9.1. Efficiency of use/conversion of resources is determined following industry protocol.9.2. Causes of low efficiency of use of resources are  Determined based on industry protocol.9.3. Plans for increasing the efficiency of resource use are developed based on findings. |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| * PPE May include but are not limited to
 | * Mask
* Gloves
* Goggles
* Safety hat
* Overall
* Hearing protector
 |
| * Environmental pollution control measures may include but are not limited to:
 | * Methods for minimizing or stopping spread and ingestion of airborne particles
* Methods for minimizing or stopping spread and ingestion of gases and fumes
* Methods for minimizing or stopping spread and ingestion of liquid wastes
 |
| * Wastes may include but are not limited to:
 | * Unnecessary waste
* Necessary waste
 |
| * Waste management Procedures may include but are not limited to:
 | * Sorting
* Storing of items
* Recycling of items
* Disposal of items
 |
| * Resources may include but are not limited to:
 | * Electric
* Water
* Fuel
* Telecommunications
* Supplies
* Materials
 |
| * Workplace environmental hazards may include but are not limited to:
 | * Biological hazards
* Chemical and dust hazards
* Physical hazards
 |
| * Organizational systems and procedures may include but are not limited to:
 | * Supply chain, procurement and purchasing
* Quality assurance
* Making recommendations and seeking approvals
 |
| * Legislations/Conventions may include but are not limited to:
 | * EMCA 1999
* Montreal Protocol
* Kyoto Protocol
 |
| * Environmental aspects/impacts may include but are not limited to:
 | * Air pollution
* Water pollution
* Noise pollution
* Solid waste
* Flood control
* Deforestation/Denudation
* Radiation/Nuclear /Radio Frequency/ Microwaves
* Situation
* Soil erosion (e.g. Quarrying, Mining, etc.)
* Coral reef/marine life protection
 |
| * Industrial standards / Environmental practices may include but are not limited to:
 | * ISO standards
* Company environmental management systems (EMS)
 |
| * Periodic may include but are not limited to:
 | * Hourly
* Daily
* Weekly
* Monthly
* Quarterly
* Yearly
 |
| * Programs/Activities may include but are not limited to:
 | * Waste disposal (on-site and off-site)
* Repair and maintenance of equipment
* Treatment and disposal operations
* Clean-up activities
* Laboratory and analytical test
* Monitoring and evaluation
* Environmental advocacy programs
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Following storage methods of environmentally hazardous materials
* Following disposal methods of hazardous wastes
* Using PPE
* Practicing OSHS
* Complying environmental pollution control
* Observing solid waste management
* Complying methods of minimizing noise Pollution
* Complying methods of minimizing wastage
* Employing waste management procedures
* Economizing resource consumption
* Listing of resources used
* Measuring current usage of resources
* Identifying and reporting workplace environmental hazards
* Conveying all environmental issues
* Following environmental regulations
* Identifying environmental regulations
* Assessing procedures for assessing compliance
* Collecting information on environmental and resource efficiency systems and procedures, and Providing information to the work group
* Measuring and recording current resource usage
* Analysing and recording current purchasing strategies.
* Analysing current work processes to access information and data and Assisting identifying areas for improvement
* Analysing resource flow
* Determining efficiency of use/conversion of resources
* Determining causes of low efficiency of use
* Developing plans for increasing the efficiency of resource use
* Checking resource use plans
* Complying to regulations/licensing requirements
* Determining benefit/cost of plans
* Ranking proposals based on benefit/cost compared to limited resources
* Checking proposals meet regulatory requirements
* Monitoring implementation
* Making adjustments to plan and implementation
* checking new resource usage

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Storage methods of environmentally hazardous materials
* Disposal methods of hazardous wastes
* Usage of PPE Environmental regulations
* OSHS
* Types of pollution
* Environmental pollution control measures
* Different solid wastes
* Solid waste management
* Different noise pollution
* Methods of minimizing noise pollution
* Methods of minimizing wstage
* Waste management procedures
* Economizing of resource consumption
* Principle of 3Rs
* Types of resources
* Techniques in measuring current usage of resources
* Calculating current usage of resources
* Types of workplace environmental hazards
* Environmental regulations
* Environmental regulations applying to the enterprise.
* Procedures for assessing compliance with environmental regulations.
* 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 current work processes to access information and data Analysis of data and information
* Identification of areas for improvement
* Resource consuming processes
* Determination of quantity and nature of resource consumed
* Analysis of resource flow of different parts of the resource flow process
* Use/conversion of resources
* Causes of low efficiency of use
* Increasing the efficiency of resource use
* Inspection of resource use plans
* Regulations/licensing requirements
* Determine benefit/cost for alternative resource sources
* Benefit/costs for different alternatives
* Components of proposals
* Criteria on ranking proposals
* Regulatory requirements
* Proposals for improving resource efficiency
* Implementation of resource efficiency plans
* Procedures in monitor implementation
* Adjustments of implementation plan
* Inspection of new resource usage

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Controlled environmental hazard
	2. Controlled environmental pollution
	3. Demonstrated sustainable resource use
	4. Evaluated current practices in relation to resource usage
	5. Demonstrated knowledge of environmental legislations and local ordinances according to the different environmental issues /concerns.
	6. Described industrial standard environmental practices according to the different environmental issues/concerns.
	7. Resolved problems/ constraints encountered based on management standard procedures
	8. Implemented and monitored environmental practices on a periodic basis as per company guidelines
	9. Recommended solutions for the improvement of the program
	10. Monitored and reported to proper authorities any environmental incidents
 |
| 1. Resource Implications
 | The following resources should be provided:* 1. Workplace with storage facilities
	2. Tools, materials and equipment relevant to the tasks (e.g. Cleaning tools, cleaning materials, trash bags)
	3. PPE, manuals and references
	4. Legislation, policies, procedures, protocols and local ordinances relating to environmental protection
	5. Case studies/scenarios relating to environmental Protection
 |
| 1. Methods of Assessment
 | Competency in this unit may be assessed through:* 1. Demonstration
	2. Oral questioning
	3. Written examination
	4. Interview/Third Party Reports
	5. Portfolio (citations/awards from GOs and NGOs, certificate of training – local and abroad)
	6. Simulations and role-play
 |
| 1. Context of Assessment
 | Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment.  |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## DEMONSTRATE OCCUPATIONAL SAFETY AND HEALTH PRACTICES

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

**UNIT DESCRIPTION**

This unit specifies the competencies required to lead the implementation of workplace’s safety and health program, procedures and policies/guidelines.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Identify workplace hazards and risk
 | 1.1 ***Hazards*** in the workplace and/or its ***indicators*** of its presence, are identified1.2 ***Evaluation and/or work environment*** measurements of OSH hazards/risk existing in the workplace is conducted by  Authorized personnel or agency1.3 ***OSH issues and/or concerns*** raised by workers are  Gathered |
| 1. Identify and implement appropriate control measures
 | 2.1 Prevention ***and control measures***, including use of  s***afety gears / PPE (personal protective equipment)*** for specific hazards  identified and implemented2.2 ***Appropriate risk controls*** based on result of OSH hazard evaluation is recommended.2.3 ***Contingency measures***, including ***emergency procedures*** during workplace ***incidents and emergencies*** are recognized and established in accordance with organization procedures. |
| 1. Implement OSH programs, procedures and policies/ guidelines
 | 3.1 Information to work team about company OSH program, procedures and policies/guidelines are provided3.2 Implementation of OSH procedures and policies/ guidelines are participated3.3 Team members are trained and advised on OSH standards and procedures3.4 Procedures for maintaining ***OSH-related records*** are implemented |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| * Hazards may include but are not limited to:
 | * Physical hazards – impact, illumination, pressure, noise, vibration, extreme temperature, radiation
* Biological hazards- bacteria, viruses, plants, parasites, mites, molds, fungi, insects
* Chemical hazards – dusts, fibers, mists, fumes, smoke, gases, vapours
* Ergonomics
* Psychological factors – over exertion/ excessive force,

awkward/static positions, fatigue, direct pressure, varying metabolic cycles* Physiological factors – monotony, personal
* relationship, work out cycle
* Safety hazards (unsafe workplace condition) –confined space, excavations, falling objects, gas leaks, electrical, poor storage of materials and waste, spillage, waste and debris
* Unsafe workers’ act (Smoking in off-limited areas, Substance and alcohol abuse at work)
 |
| * Indicators may include but are not limited to:
 | * Increased of incidents of accidents, injuries
* Increased occurrence of sickness or health complaints/ symptoms
* Common complaints of workers related to OSH
* High absenteeism for work-related reasons
 |
| * Evaluation and/or work environment measurements may include but are not limited to:
 | * Health Audit
* Safety Audit
* Work Safety and Health Evaluation
* Work Environment Measurements of Physical and Chemical
* Hazards
 |
| * OSH issues and/or concerns may include but are not limited to:
 | * Workers’ experience/observance on presence of work hazards
* Unsafe/unhealthy administrative arrangements (prolonged work hours, no break time, constant overtime, scheduling of tasks)
* Reasons for compliance/non-compliance to use of PPEs or other OSH procedures/policies/guidelines
 |
| * Prevention and control measures may include but are not limited to:
 | * Eliminate the hazard (i.e., get rid of the dangerous machine
* Isolate the hazard (i.e. keep the machine in a closed room and operate it remotely; barricade an unsafe area off)
* Substitute the hazard with a safer alternative (i.e., replace the machine with a safer one)
* Use administrative controls to reduce the risk (i.e. give trainings on how to use equipment safely; OSH-related topics, issue warning signages, rotation/shifting work schedule)
* Use engineering controls to reduce the risk (i.e. use safety guards to machine)
* Use personal protective equipment
* Safety, Health and Work Environment Evaluation
* Periodic and/or special medical examinations of workers
 |
| * Safety gears /PPE (Personal Protective Equipment) may include but are not limited to:
 | * 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
 |
| * Appropriate risk controls
 | * Appropriate risk controls in order of impact are as follows:
* Eliminate the hazard altogether (i.e., get rid of the dangerous machine)
* Isolate the hazard from anyone who could be harmed (i.e., keep the machine in a closed room and operate it remotely; barricade an unsafe area off)
* Substitute the hazard with a safer alternative (i.e., replace the machine with a safer one)
* Use administrative controls to reduce the risk (i.e., train workers how to use equipment safely; train workers about the risks of harassment; issue signage)
* Use engineering controls to reduce the risk (i.e., attach guards to the machine to protect users)
* Use personal protective equipment (i.e., wear gloves and goggles when using the machine)
 |
| * Contingency measures may include but are not limited to:
 | * Evacuation
* Isolation
* Decontamination
* (Calling designed) emergency personnel
 |
| * Emergency procedures may include but are not limited to:
 | * Fire drill
* Earthquake drill
* Basic life support/CPR
* First aid
* Spillage control
* Decontamination of chemical and toxic
* Disaster preparedness/management
* Use of fire-extinguisher
 |
| * Incidents and emergencies may include but are not limited to:
 | * Chemical spills
* Equipment/vehicle accidents
* Explosion
* Fire
* Gas leak
* Injury to personnel
* Structural collapse
* Toxic and/or flammable vapors emission.
 |
| * OSH-related Records may include but are not limited to:
 | * Medical/Health records
* Incident/accident reports
* Sickness notifications/sick leave application
* OSH-related trainings obtained
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Skills on preliminary identification of workplace hazards/risks
* Knowledge management
* Critical thinking skills
* Observation skills
* Coordinating skills
* Communication skills
* Interpersonal skills
* Troubleshooting skills
* Presentation skills
* Training skills

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* General OSH Principles
* Occupational hazards/risks recognition
* OSH organizations providing services on OSH evaluation and/or work environment measurements (WEM)
* National OSH regulations; company OSH policies and protocols
* Systematic gathering of OSH issues and concerns
* General OSH principles
* National OSH regulations
* Company OSH and recording protocols, procedures and policies/guidelines
* Training and/or counseling methodologies and strategies

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:1. Identifies hazards/risks in the workplace and/or its indicators
2. Requests for evaluation and/or work environment measurements of OSH hazards/risk in the workplace
3. Gathers OSH issues and/or concerns raised by workers
4. Identifies and implements prevention and control measures, including use of PPE (personal protective equipment) for specific hazards
5. Recommends appropriate risk controls based on result of OSH hazard evaluation and OSH issues gathered
6. Establish contingency measures, including emergency procedures in accordance with organization procedures
7. Provides information to work team about company OSH program, procedures and policies/guidelines
8. Participates in the implementation of OSH procedures and policies/guidelines
9. Trains and advises team members on OSH standards and procedures
10. Implements procedures for maintaining OSH-related records
 |
| 1. Resource Implications
 | The following resources should be provided:2.1 Workplace or assessment location2.2 OSH personal records2.3 PPE2.4 Health records |
| 1. Methods of Assessment
 | Competency may be assessed through:3.1 Portfolio Assessment3.2 Interview3.3 Case Study/Situation3.4 Observation/Demonstration and oral questioning |
| 1. Context of Assessment
 | Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment.  |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

# COMMON UNITS OF COMPETENCY

## APPLY WATER QUALITY PRINCIPLES

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

**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.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENTS**These describe the **key outcomes** which make up **workplace function.** | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range.*** |
| 1. Apply inorganic chemistry principles
 | 1. Structure of atoms are illustrated based on Bohr’s atomic model
2. Electron arrangement of the first 30 elements of the periodic table are illustrated based on ***quantum numbers*** and ***electronic configuration rules***
3. The periodic table is analyzed based on groups, periods and ***blocks***
4. Acid-base properties of ***compounds of period three*** elements are analyzed based on dissolution and hydrolysis
5. ***Chemical bonds*** are identified based on their properties
6. ***Chemical structures*** of substances are represented based on ***chemical bonding***
7. ***Hazardous chemicals*** are identified based on globally harmonized system of classification and labeling of chemical
8. ***Units of concentrations*** are determined based on ***physical states***
9. ***Chemical reactions*** are illustrated based on stoichiometric principles
10. ***Chemical reagents*** and ***solutions*** are prepared based on standard procedures
11. Chemical safety is observed based on good Laboratory Practice
 |
| 1. Apply Organic Chemistry Principles
 | 1. Organic compounds are classified based on functional groups.
2. Plastics are identified based on plastics identification code
3. Aerobic and anaerobic processes in water treatment are identified based on biochemical principles
 |
| 1. Apply Physical Chemistry Principles
 | 1. Corrosion is illustrated using electrochemical principles.
2. Calculations involving redox reactions are performed based on electrochemical series.
3. Problems on gases are solved based on kinetic theory and gas laws.
4. Solubility of substances compared based on solubility product.
5. Salts are classified based on their interactions with water.
6. Solutions are prepared based on user requirements.
7. Unknown concentrations are determined based on stoichiometric principles.
8. Calculations involving chemical kinetics in aqueous medium are performed as per the rate law.
9. Calculations involving chemical equilibria are performed based on Le Chatelet’s principle.
10. Enthalpy of reactions determined based on thermochemistry principles.
11. Calculations involving thermal equilibria carried out are based on laws of thermodynamics.
 |
| 1. Apply Water Chemistry Principles
 | 1. Chemical bonding and structure of water is illustrated based on Bohr’s atomic model
2. Unique Properties of water are identified based on characteristics of similar compounds
3. Levelling effect of water is illustrated based on chemical equilibria
4. Buffering capacity of water is illustrated based on the carbonate system
5. Solubility of substances in water is determined based on solubility rules
6. Water pollution is evaluated based on type of pollutants
7. Water treatment methods are evaluated based on processes involved
8. Wastewater treatment methods are evaluated based on processes involved
 |
| 1. Apply chemical water quality principles
 | * 1. Physicochemical parameters of water quality are identified based on KEBS standards and NEMA regulations
	2. Chemical parameters of water quality are identified based on KEBS water quality standards and NEMA effluent discharge regulations
	3. Water and effluents for physical/chemical analysis are sampled based on standard operating procedures
	4. Physicochemical parameters of water quality are determined based on job requirements.
	5. Chemical parameters of water quality are determined based on job requirements.
	6. Physical and chemical water quality test reports are interpreted based on job requirements
	7. Laboratory safety is observed in accordance with GLP
 |
| 1. Apply Microbiology Principles
 | * 1. Living organisms classified based on the 5-kingdom system
	2. Cells of organisms are classified based on structure
	3. Microorganisms are classified based on their ecological niche
	4. Water related infections are identified based on causative agents
	5. Aquatic ecosystems are maintained based on principles of ecology
	6. General biosafety is observed in accordance with GLP
 |
| 1. Apply microbial water quality principles
 | * 1. Microbiological limits of water quality are identified in accordance with on national standards and regulations
	2. Water and effluents for microbial analysis are sampled based on standard operating procedures
	3. Microbial parameters of water quality are determined using light and microbiology techniques
	4. Microbiological water quality reports are interpreted based on national water quality standards and regulations.
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| * Quantum numbers may include but is not limited to:
 | * Principal quantum
* Angular momentum quantum number
* Magnetic quantum number
* Electron spin quantum number
 |
| * Electronic Configuration rules may include but is not limited to:
 | * Main shell rule (2n2 )
* Sub-shell rules
* Hund’s rule
* Pauli Exclusion Principle
* Aufbau Principle
 |
| * Units of concentration may include but is not limited to:
 | * equivalent weight
* Normality
* Percentage
 |
| * Chemical reactions may include but `is not limited to:
 | * Precipitation
* Acid-base neutralization
* Redox
* Displacement reactions as redox reactions
 |
| * Toxic effects may include but is not limited to:
 | * Chronic
* Acute
 |
| * Structure may include but is not limited to:
 | * Acellular
* Cellular
* Prokaryotic
* Eukaryotic
 |
| * Ecological niche may include but is not limited to:
 | * Habitat
* Role
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Problem solving
* Supervising
* Time management
* Instrumentation
* Standard Operating Procedures
* Water sampling
* Water quality testing
* Solutions preparation
* Titration
* GLP
* Report writing

**Required Knowledge**

* Stoichiometry
* Pathogens
* Chemical kinetics and chemical equilibria
* MSDS
* GHS
* SOPs

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge and understanding and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency
 | Assessment requires evidence that the candidate:1. Determined acid-base properties of compounds based on
2. Identified hazardous chemicals based on globally harmonized system of classification and labeling of chemicals
3. Observed general biosafety based on good laboratory practice
4. Prepared chemical solutions based on SOPs.
5. Classified plastics and polymers based on plastics identification code
6. Identified aerobic and anaerobic processes in water quality testing and wastewater treatment based on biochemical principles
7. Determined solubility of substances in water is based on solubility rules
8. . Identified unique properties of water based on characteristics of similar compounds
9. Illustrated levelling effect of water based on chemical equilibria
10. Classified microorganisms based on their pathogenic effects.
11. Conducted water quality tests based on job requirements
12. Preserved aquatic ecosystems based on principles of ecology
13. Observed safety based on GLP
 |
| 1. Resource Implications
 | 1. Periodic table
2. Chemicals and reagents
3. Analytical balances
4. Water quality test kits
5. Microscopes
6. Autoclave
7. Water bath
8. Basic laboratory installations
 |
| 1. Methods of Assessment
 | Competency may be assessed through:1. Written tests
2. Observation
3. Oral questioning
 |
| 1. Context of Assessment
 | Assessment may be done: 1. On–the–job
2. Off-the –job
3. Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY PHYSICS PRINCIPLES

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

**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.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENTS**These describe the **key outcomes** which make up **workplace function.** | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range.*** |
| 1. Perform measurements of various quantities.
 | * 1. ***Basic quantities and derived* quantities** are identified based on the SI units
	2. Inter conversion of units is performed in accordance with appropriate systems of measurement
	3. Dimensional analysis is performed in accordance to units of measurement
	4. Measurements are performed using suitable **instruments** in accordance with appropriate units
 |
| 1. Apply principles of forces
 | * 1. ***Forces*** and their effects are identified in accordance to work place tasks
	2. Moment of a force and its SI unit is determined in accordance with work place tasks
	3. Forces are resolved in accordance with workplace tasks
	4. Resultant forces are determined as per reference
	5. The principle of moments is applied to solve problems as per reference
	6. Centre of gravity of objects is determined in accordance to moments
	7. Laws of friction are applied as per reference
	8. Effects of friction are identified based on experiments
	9. Benefits of reducing friction are described as applied to maintaining machines
	10. Tools and equipment are operated based on standard operating procedures (SOPs)
 |
| 1. Apply principles of classical mechanics
 | * 1. Laws of linear *motion* are applied as per reference

3.2 Parameters of motion are calculated based on the laws of motion.* 1. Force formula is derived in accordance with laws of motion
	2. Motion under gravity is determined in accordance to the laws of motion
	3. Motion graphs are drawn based on parameters of motion.
	4. Forms of energy and energy transformations are identified based on reference
	5. Sources of energy are identified based on the forms of energy
	6. Problems on work, energy and power are solved based on standard formulas.
 |
| 1. Apply principles of heat transfer
 | * 1. Modes of heat transfer are identified based on the type of material
	2. Heat transfer is applied based on the modes
	3. Thermal expansion is identified based on the type of materials
	4. Thermal expansion is applied based on the type of materials
 |
| 1. Apply principles of waves and oscillations
 | * 1. Laws of reflection and refraction are applied to determine distance, size objects and refractive indices based on the type of material
	2. Properties of waves are applied based on the effects of resonance to structures
	3. Propagation of sound is applied to perform calculations based on relation amplitude, wavelength, frequency, and distance analyzed
 |
| 1. Apply principles of density and pressure
 | * 1. Laws and principles appropriate to fluid pressure are applied in accordance with reference
	2. Atmospheric and fluid pressures are determined using pressure gauging instruments.
 |
| 1. Apply Principles of Electromagnetic Induction
 | * 1. Concepts and terminology in electromagnetic induction are explained based on electromagnetic principles.
	2. Identify Magnetic parameters as per relevant laws of magnetism.
	3. Magnetic properties of materials are determined in accordance with the orientation of the magnetic dipole orientation.
	4. Induced e.m.f. and current are identified as coupled based on Faraday’s laws of electromagnetic induction.
	5. Lenz’s law is explained based on the direction of the induced e.m.f.
	6. Applications of electromagnetic induction are demonstrated based on the requirements of water laboratory.
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| * Motion may include but is not limited to:
 | * Linear
* projectile
 |
| * Forms of energy may include but is not limited to:
 | * Kinetic
* Potential
 |
| * Types of waves may include but is not limited to:
 | * Transverse
* Longitudinal
 |
| * Forms of waves may include but is not limited to:
 | * Mechanical
* Electromagnetic
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required skills**

The individual needs to demonstrate the following skills:

**Generic skills**

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Problem solving
* Supervising
* Time management

**Technical skills**:

* Measurement
* Instrumentation
* Calibration
* Report writing

**Required Knowledge**

* States of matter
* Laws of motion
* Optics
* Waves

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge and understanding and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency
 | **Assessment requires evidence that the candidate:**1. Performed measurement of the physical quantities based on standard procedures.
2. Determined resultant forces and their effects based on workplace tasks.
3. Determined and solved problems on work, energy and power based on standard formulas.
4. Identified modes of heat transfer in according to the transmission media.
5. Quantity of heat is determined based on enthalpy.
6. Temperature changes are illustrated based on latent heat.
7. Illustrated change in physical state based on latent heat
8. Demonstrated optical properties of light based on principles of optics.
9. Constituents of electromagnetic spectrum are identified based on wavelength.
10. Wave-particle nature of light is evaluated based on de Broglie’s hypothesis.
11. Linear propagation of light is demonstrated based on pinhole camera.
12. Evaluated pressure in fluids based on Pascal’s law.
13. Applied principles and laws to fluid pressure in accordance with reference.
14. Determined atmospheric and fluid pressures using pressure gauging instruments.
15. Selected materials for work based on their magnetic properties
16. Demonstrated applications of electromagnetic induction based on requirements of water laboratory.
 |
| 1. Resource Implications
 | The following resources **should** be provided:* 1. Analytical balances
	2. Physics laboratory
	3. Micrometer screw gauge
	4. Vernier calipers
	5. Meter rules
	6. Simple machines
	7. Glass prisms
	8. Lenses
	9. Plane and curved mirrors
	10. Optical bench
 |
| 1. Methods of Assessment
 | Competency may be assessed through:1. Written tests
2. Observations
3. Interviews
4. Third party reports
 |
| 1. Context of Assessment
 | Assessment may be done: -1. On–the–job
2. Off-the –job
3. Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY ENGINEERING MATHEMATICS

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

**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.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT** These describe the **key outcomes** which make up **workplace function**. | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range.*** |
| --- | --- |
| * 1. Apply Algebra
 | * 1. Calculations involving Indices are performed as per the concept
	2. Calculations involving Logarithms are performed as per the concept
	3. Scientific calculator is used in solving mathematical problems in line with manufacturer’s manual
	4. Simultaneous equations are performed as per the rules
	5. Quadratic equations are calculated as per the concept
 |
| * 1. Apply Trigonometry and hyperbolic functions
 | * 1. Calculations are performed using trigonometric rules
	2. Calculations are performed using hyperbolic functions
 |
| * 1. Apply complex numbers
 | * 1. Complex numbers are represented using Argand diagrams
	2. Operations involving complex numbers are performed
	3. Calculations involving complex numbers are performed using De Moivre’s theorem
 |
| * 1. Apply Coordinate Geometry
 | * 1. Polar equations are calculated using coordinate geometry
	2. Graphs of given polar equations are drawn using the Cartesian plane
	3. Normal and tangents are determined using coordinate geometry
 |
| * 1. Carry out Binomial Expansion
 | * 1. Roots of numbers are determined using binomial theorem
	2. Errors of small changes are determined using binomial theorem
 |
| * 1. Apply Calculus
 | * 1. Derivatives of functions are determined using Differentiation
	2. Derivatives of hyperbolic functions are determined using Differentiation
	3. Derivatives of inverse trigonometric functions are determined using Differentiation
	4. Rate of change and small change are determined using Differentiation.
	5. Calculation involving stationery points of functions of two variables are performed using differentiation.
	6. Integrals of algebraic functions are determined using integration
	7. Integrals of trigonometric functions are determined using integration
	8. Integrals of logarithmic functions are determined using integration
	9. Integrals of hyperbolic and inverse functions are determined using integration
 |
| * 1. Solve Ordinary differential equations
 | * 1. First order and second order differential equations are solved using the method of undetermined coefficients

7.2 First order and second order differential equations are solved from given boundary conditions |
| * 1. Carry out Mensuration
 | * 1. Perimeter and areas of figures are obtained
	2. Volume and of Surface area of solids are obtained
	3. Area of irregular figures are obtained
	4. Areas and volumes are obtained using Pappus theorem
 |
| * 1. Apply Power Series
 | * 1. Power series are obtained using Taylor’s Theorem
	2. Power series are obtained using McLaurin’s ‘s theorem
 |
| * 1. Apply Statistics
 | * 1. Mean, median, mode and Standard deviation are obtained from given data
	2. Calculations are performed based on Laws of probability
	3. Calculation involving *probability distributions*, mathematical expectation sampling distributions are performed
	4. Sampling distribution methods are applied in data analysis
	5. Calculations involving use of standard normal table, sampling distribution, T-distribution and Estimation are done
	6. Confidence intervals are determined
 |
| * 1. Apply Numerical methods
 | * 1. Roots of polynomials are obtained using iterative *numerical methods*
	2. Interpolation and extrapolation are performed using numerical methods
 |
| * 1. Apply Vector theory
 | * 1. Vectors and scalar quantities are obtained in two and three dimensions
	2. *Operations* on vectors are performed
	3. Position of vectors is obtained
	4. Resolution of vectors is done
 |
| * 1. Apply Matrices
 | * 1. Determinant and inverse of 3x3 matrix are obtained
	2. Solutions of simultaneous equations are obtained
	3. Calculation involving Eigen values and Eigen vectors are performed
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| * Operation smay include but not limited to:
 | * Addition
* Subtraction
 |
| * Hyperbolic functions may include but not limited to:
 | * Sinh x
* Cosh x
* Cosec x
* Coth x
* Tanh x
* Sech x
 |
| * Probability Distributions may include but not limited to:
 | * Binomial
* Poisson
* Normal
 |
| * Numerical Methods may include but not limited to:
 | * Newton Raphson
* Gregory Newton
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Analytical
* Communication
* Logical thinking
* Problem solving
* Drawing
* Sketching
* Interpersonal
* Organization

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Mensuration
* Vector operations
* Matrix operations
* Calculus
* Statistics
* Ordinary differential equations
* Power series
* Complex numbers
* Algebra
* Trigonometry and hyperbolic functions
* Coordinate Geometry
* Binomial Expansion
* Numerical methods

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency
 | Assessment requires evidence that the candidate: 1. Applied algebra correctly.
2. Applied Trigonometry and hyperbolic functions correctly.
3. Applied complex numbers correctly.
4. Applied Calculus correctly.
5. Solved Ordinary differential equations correctly.
6. Carried out mensuration correctly.
7. Applied Power Series correctly.
8. Applied Vector theory correctly.
9. Applied Matrix correctly.
10. Applied Numerical methods correctly.
11. Applied statistics correctly.
12. Applied binomial expansion correctly.
13. Applied co-ordinate geometry correctly.
 |
| 1. Resource Implications
 | The following resources should be provided: 1. Access to relevant workplace or appropriately simulated environment where assessment can take place
2. Measuring equipment
3. Materials relevant to the proposed activity or tasks
 |
| 1. Methods of Assessment
 | Competency in this unit may be assessed through: 1. Written tests
2. Observation
3. Oral Questioning
 |
| 1. Context of Assessment
 | Competency may be assessed:1. On-the –job
2. Off-the-job
3. Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY ELECTRICAL AND MECHANICAL TECHNIQUES

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

**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.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENTS**These describe the **key outcomes** which make up **workplace function.** | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range.*** |
| 1. Apply electrical and electronic principles
 | 1. Electric circuits are interpreted as per principles of flow of charge.
2. Electrical instruments are identified based job requirements
3. Electrical measurements are conducted based job requirements
4. Errors in electrical measurement are analyzed based on IEE guidelines
5. Circuits diagrams are interpreted as per electric codes and symbols
6. Electrical and electronic installations are conducted as per manufacturers’ manuals
 |
| 1. Operate and maintain alternative power sources
 | * 1. Alternative sources of power for water pumping are identified analyzed based on job requirements.
	2. Alternative sources of power are operated and maintained according to standard operating procedures
 |
| 1. Apply pump working principles
 | * 1. Fluid pumping terms and units are interpreted according to fluid machine principles
	2. Pumps are selected based on job requirements
	3. Fluid pumping calculations are performed based on fluid flow principles and laws
	4. Pump performance parameters are interpreted based on fluid machine principles
	5. Pumping sets are operated in accordance with SOPs.
	6. Pump maintenance schedules are prepared based on manufacturer’s instructions.
	7. Maintenance tasks for pumping systems are conducted based on SOPs.
 |

**RANGE**

This section provides work environments and conditions to which the performance

criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable**  | **Range** |
| * Alternative sources of electric power may include but is not limited to:
 | * Solar power
* Wind energy
* Geothermal power
* Natural gas
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required skills**

The individual needs to demonstrate the following skills:

**Generic skills**

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Problem solving
* Supervising
* Time management

**Technical skills**:

* Instrumentation
* Standard operating procedures
* Calibration
* Report writing
* Pump selection

**Required Knowledge**

* Control Instrumentation
* Electrical practice
* Motor operations

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge and understanding and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency
 | **Assessment requires evidence that the candidate:**1. Interpreted electric circuits based on the path of flow of charge.
2. Carried our electrical measurement based on need
3. Evaluated errors in electrical measurement based on accuracy of the instruments and general integrity failure.
4. Interpreted R-L-C circuits as per the symbols.
5. Used electrical hand tools in operation and maintenance based on the nature of work
6. Operated and maintained of alternative sources of electric power based on the alternative source available and need.
7. Observed safety in work and equipment based on SOPs.
8. Selected pumps based on the job requirements.
9. Operated and maintained pumps based on SOPs.
 |
| 1. Resource implications
 | The following resources **must** be provided:1. Electrical tools
2. Pumps
3. Alternative power sources
 |
| 1. Methods of assessment
 | Competency may be assessed through:1. Written tests
2. Observations
3. Interviews
4. Third party reports
 |
| 1. Context of assessment
 | Assessment may be done: -1. On–the–job
2. Off-the –job
3. Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY WORKSHOP TECHNOLOGY

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

**UNIT DESCRIPTION**

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

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT** These describe the **key outcomes** which make up **workplace function.** | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***(Bold and italicized terms are elaborated in the Range)*** |
| --- | --- |
| 1. Apply workshop safety measures
 | * 1. Personal Protective Equipment (PPE)aroused based on manufacturer’s instructions, Nature of hazard and legal requirements.
	2. Safety measures are observed based on workshop safety rules and regulations
	3. Safety provisions are implemented based on National OSH guidelines
	4. First Aid is administered based on standard operation procedures
 |
| 1. Select Engineering Materials for workshop operations
 | 2.1 Engineering materials are classified based on Crystalline structure and chemical make up2.2 Properties of engineering materials are identified based on conventional standards2.3 Engineering Materials are selected based on workshop operations and engineering service conditions2.4 Construction materials are selected based on workshop operations and engineering service conditions  |
| 1. Perform masonry tasks
 | 3.1Masonry hand and machine tools are identified selected based on job requirement* 1. Materials and supplies for masonry works are identified and selected based job requirements.
	2. Masonry tools are used as per manufacturer’s specifications
	3. Masonry tasks are performed based on instructions.
	4. Masonry machines and equipment are troubleshot and reported based on SOPs.
	5. Masonry tools are maintained as per manufacturer’s specifications
 |
| 1. Perform carpentry tasks
 | 4.1Carpentry hand tools and machines are identified and selected based job requirements. * 1. Materials and supplies for carpentry works are identified and selected as per job requirements
	2. Carpentry hand tools and machines are used as per manufacturer’s specifications
	3. Carpentry tasks are performed based on instructions
	4. Carpentry machines and equipment are troubleshooting and reported based on SOPs.

4.6 Carpentry tools are maintained as per manufacturer’s specifications |
| 1. Perform general electrical tasks
 | 1. Electrical hand and machine tools are identified and selected based on job requirement
2. Materials and supplies are identified selected based on job requirement
3. Electrical instruments for electric works are identified and selected based job requirements.
4. Electrical tools are used as per manufacturer’s specifications
5. Electrical tasks are performed based on instructions.
6. Electrical machines and equipment are troubleshot and reported based on SOPs.
7. Electrical tools are maintained as per manufacturer’s specifications
 |
| 1. Perform plumbing and pipefitting tasks
 | * 1. Plumbing and pipe fitting hand and machine tools are identified and selected based on job requirement
	2. Materials and supplies for plumbing and pipe works are identified and selected based job requirements.
	3. Plumbing and pipe fitting hand and machine tools are used as per manufacturer’s specifications
	4. ***Plumbing and pipe fitting tasks*** are performed based on procedures manual
	5. Plumping and pipe fitting machines and equipment are troubleshooting and reported based on SOPs.
 |
| 1. Perform general welding tasks
 | 7.1 Welding hand and machine tools are identified selected based on job requirements* 1. Materials and supplies for welding works are identified and selected based job requirements.
	2. Welding tools are used as per manufacturer’s specifications
	3. Welding tasks are performed based on instructions.
	4. Welding machines and equipment are troubleshooting and reported based on SOPs.
	5. Welding tools are maintained as per manufacturer’s specifications
 |
| 1. Perform basic mechanical fitting tasks
 | 8.1 Mechanical hand and machine tools are identified selected based on job requirement* 1. Materials and supplies for mechanical works are identified and selected based job requirements.
	2. Welding mechanical tools are used as per manufacturer’s specifications
	3. Mechanical tasks are performed based on instructions.
	4. Mechanical machines and equipment are troubleshot and reported based on SOPs
	5. Mechanical tools are maintained as per manufacturer’s specifications
 |
| 1. Manage workshop wastes
 | 1. Workshop is cleaned and waste managed and disposed as per workplace policy and legal requirements
2. Recyclable supplies are cleaned and stored as per workplace policy and legal requirement.
3. Non-Recyclable supplies are cleaned and stored as per workplace policy and legal requirement.
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| * + - Plumbing and pipe fitting tasks may include but not limited to
 | * Water supply pipeline
	+ Small diameter
	+ Large diameter > 2 inches
* Waste water systems
* Water storage and reticulation systems
* Solar heated water systems
* Irrigation systems
	+ Drip
	+ Hydroponics
	+ Sprinklers
	+ Dam and pan liners
* Sanitary systems
	+ Sinks
	+ Toilets
	+ Urinals
	+ Bathtubs
	+ showers
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required skills**

The individual needs to demonstrate the following skills:

* Critical thinking
* Problem solving
* Firefighting
* Quality control
* Circuit interpretation

**REQUIRED KNOWLEDGE**

The individual needs to demonstrate knowledge of:

* Communication
* Analytical
* Tools and equipment
* Safety regulations
* Mathematics
* Electrical installation
* Electric Power supply
* Engine operations
* Motor operations
* Plumbing
* Water pump operation
* Masonry
* Mortar mixing
* General welding
* Firefighting
* Electric Circuit interpretation

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Used Personal Protective Equipment (PPE) based on manufacturer’s instructions, Nature of hazard and legal requirements.
	2. Observed Safety measures based on workshop safety rules and regulations
	3. Implemented Safety provisions based on DoSHs guidelines
	4. Selected Engineering Materials based on workshop operations and engineering service conditions
	5. Selected Construction materials based on workshop operations and engineering service conditions
	6. Used masonry tools as per manufacturer’s specifications
	7. Performed Masonry tasks based on work instructions.
	8. Troubleshot masonry machines and equipment and reported based on SOPs.
	9. Performed Carpentry tasks based on instructions
	10. Troubleshot and reported Carpentry machines and equipment based on SOPs.
	11. Used electrical tools as per manufacturer’s specifications
	12. Performed Electrical tasks based on instructions.
	13. Troubleshot Electrical machines and equipment and reported based on SOPs.
	14. Performed plumbing and pipe fitting tasks based on instructions.
	15. Troubleshot plumping and pipe fitting machines and equipment and reported based on SOPs.
	16. Performed welding tasks based on work instructions.
	17. Troubleshot and reported Welding machines and equipment based on SOPs.
	18. Performed mechanical tasks based on instructions.
	19. Troubleshot and reported mechanical machines and equipment based on SOPs.
	20. Handled Recyclable and non-Recyclable supplies as per workplace policy and legal requirement.
 |
| 1. Resource Implications
 | The following resources should be provided:* 1. Construction workshop
	2. Carpentry workshop
	3. Electrical workshop
	4. Plumbing and pipefitting workshop
	5. Welding workshop
	6. Mechanical workshop
 |
| 1. Methods of Assessment
 | Competency may be assessed through:* 1. Written text
	2. Interview
	3. Observation
 |
| 1. Context of Assessment
 | Competency may be assessed on the job, off the job or a combination of these. Off the job assessment must be undertaken in a closely simulated workplace environment.  |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY TECHNICAL DRAWINGS AND COMPUTER AIDED DESIGN PRINCIPLES

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

**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.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***(Bold and italicized terms are elaborated in the Range)*** |
| 1. Use and maintain drawing equipment and materials
 | 1.1 Drawing equipment are identified and gathered according to task requirements1.2 Drawing materials are identified and gathered according to task requirements 1.3 Drawing equipment are used and maintained as per manufacturer’s instructions1.4 Drawing materials are used as per workplace procedures1.5 Symbols and abbreviations are identified and their meaning interpreted according to standard drawing conventions |
| 1. Produce plane geometry drawings
 | 2.1 Different types of lines used in drawing and their meanings are identified according to standard drawing conventions2.2. Lettering is done in accordance with BS308. 2.3. Different types of scales are constructed and interpreted according to standard conventions.2.4 Different types of angles are constructed according to standard conventions.2.5 Different types of ***geometric forms*** are constructed according to standard conventions |
| 1. Produce solid geometry drawings
 | * 1. Drawings of patterns are interpreted according to standard conventions
	2. Surface developments are produced using standard conventions
	3. True shapes, plans and elevations are developed in accordance with standard conventions
	4. Freehand sketching is done based on standard format.
 |
| 1. Produce 3D drawings
 | 1. First and third angle orthographic drawings are interpreted and produced in accordance with the standard conventions
2. Orthographic elevations are dimensioned in accordance with standard conventions
3. Isometric drawings are interpreted and produced in accordance with standard conventions
 |
| 1. Produce working drawings
 | * 1. Suitable scales are identified and interpreted according to standard conventions
	2. Plans, elevations and section drawings are produced according to standard conventions.
	3. Cross sections and profiles of water structures are produced according to standard conventions
	4. Dimensioning is done to working drawings according to standard
 |
| 1. Apply CAD packages
 | * 1. CAD packages are selected according to task requirements
	2. CAD packages are applied in production of drawings
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

| **Variable** | **Range** |
| --- | --- |
| * Geometric forms
 | * Circles
* Triangles
* Rectangles
* Parallelogram
* Polygons
* Pyramids
* conic sections
* prisms
* loci
 |
| * Solid geometry
 | * Cubes
* Cuboids
* Pyramids
* Cones
* Cylinders
* Truncated cones
* Pyramids
* Cylinders
* Interpenetration
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required skills**

The individual needs to demonstrate the following skills:

* Communication
* Critical thinking
* Drawing
* Interpretation
* Drawing equipment handling
* Analysis and synthesis
* Inter personal

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Drawing equipment and materials
* Freehand sketching
* Lettering
* Geometrical constructions
* Types of drawings
* Types of lines
* Isometric drawing conventions, features, characteristics, components
* Orthographic drawing conventions, features, characteristics, components
* Sketches and drawings of simple patterns

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge and understanding and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Used and maintained Drawing equipment as per manufacturer’s instructions
	2. Used Drawing materials as per workplace procedures
	3. Constructed different types of scales and interpreted according to standard conventions.
	4. Constructed Different types of angles according to standard conventions.
	5. Constructed Different types of geometric forms according to standard conventions
	6. Interpreted Drawings of patterns according to standard conventions
	7. Produced Surface developments using standard conventions
	8. Developed True shapes, plans and elevations in accordance with standard conventions
	9. Interpreted First and third angle orthographic drawings and produced in accordance with the standard conventions
	10. Dimensioned Orthographic elevations in accordance with standard conventions
	11. Interpreted and produced isometric drawings are in accordance with standard conventions
	12. Applied CAD packages in production of drawings
 |
| 1. Resource Implications
 | Resources the same as that of workplace are advised to be applied.1. Drawing room
2. Drawing equipment and materials
3. Computers
4. CAD packages
 |
| 1. Methods of Assessment
 | Competency may be assessed through:1. Practical tests
2. Observation
 |
| 1. Context of Assessment
 | Competency may be assessed individually in the actual workplace or a simulated work place setting |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY WATER TECHNOLOGY PRINCIPLES

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

**UNIT DESCRIPTION**

This unit describes the competence required to apply water technology principles. It involves applying: water supply principles and wastewater collection and treatment principles.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT** These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***(Bold and italicized terms are elaborated in the Range)*** |
| --- | --- |
| 1. Apply water supply principles
 | 1. Water demand is calculated based on particular use
2. Sources of water are established based on demand and particular use.
3. Water abstraction methods are analyzed based on the water source
4. Water treatment processes are demonstrated based on water characteristics and water quality.
5. Water pipes and appurtenances are assessed based on the design
6. Water supply symbols are interpreted based on international standards
7. Water distribution systems are evaluated based on design
8. Water storage structures are evaluated based on water system
9. Work safety is observed based on code of practice
 |
| 1. Apply wastewater collection and treatment principles
 | * 1. Wastewater is characterized based on effluent discharge regulations (NEMA).
	2. Wastewater treatment processes are selected based on wastewater characteristics and intended use
	3. Treated Waste water is re-used for irrigation based on content of contaminants and type of plant.
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Analytical
* Critical thinking
* Problem solving
* Firefighting
* Quality control
* Circuit interpretation

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Tools and equipment
* Safety regulations
* Mathematics
* Water cycle
* Water pipes
* Plumbing
* Water pump operation
* Pipe fitting

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Calculated water demand based on the particular water use
	2. Demonstrated water treatment processes based on water characteristics and intended use
	3. Evaluated water supply symbols based on international standards.
	4. Interpreted water distribution systems based on the design.
	5. Selected water storage structures based on available resources
	6. Characterized wastewater based on effluent discharge regulations.
	7. Selected water treatment processes based on waste water characteristics and intended use.
	8. Re-used waste water for irrigation based on content of contaminants and type of crop.
 |
| 1. Resource Implications
 | The following resources **must** be provided:1. Scientific calculator
2. Water distribution system models
3. Population forecasting charts
4. Water supply symbols charts
5. Masonry and plastic tank models
6. Model sewer system
7. Wastewater laboratory
8. Water quality laboratory
9. Wastewater symbols chart
10. Demonstration farm
11. Demonstration safety gear
 |
| 1. Methods of Assessment
 | Competency may be assessed through:1. Written tests
2. Interview
3. Observation
 |
| 1. Context of Assessment
 | 1. On–the–job
2. Off-the –job
3. Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY SOIL AND CROP SCIENCE PRINCIPLES

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

**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.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT** These describe the **key outcomes** which make up **workplace function**. | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range.*** |
| 1. Determine soil properties
 | 1. Physical properties of soil are determined based on USDA classification systems
2. Chemical properties of soils are identified based on mineral composition
3. Biological properties of soil are identified based on organic matter content
 |
| 1. Identify inorganic and organic fertilizers
 | 1. Fertilizes are classified based on their origin and nutrients they supplied
2. Methods of fertilizer application are identified based on manufacturers specification
 |
| 1. Determine soil water plant relationship
 | * 1. Components of soil and plant water potential are determined based on properties of soil
	2. Water and mineral nutrients movement in soil and uptake by crops are determined based on properties of the soil
	3. Soil moisture is determined using moisture sensors
 |
| 1. Determine crop water requirements
 | 1. Crops are identified based on farmer’s preference.
2. Quality of irrigation water is analyzed based on the standards
3. Crop water requirement is calculated using relevant software
 |
| 1. Develop a cropping program
 | * 1. Types and number of crops are identified based on farmer preference.
	2. The farm is divided based on the type and number of crops identified.
	3. Cropping calendar is prepared based on the market.
	4. Planting is carried out based on the cropping calendar prepared.
 |
| 1. Implement a crop husbandry schedule
 | * 1. Crop husbandry activities are established based on the types of crops
	2. Irrigation methods are evaluated based on the type of crop, type of soil, resources available, quantity and quality of water
	3. Methods of drainage are determined based on crop water requirement, type of soil, quantity and quality of water.
	4. A calendar of activities is prepared based on types of crops and crop growth cycle.
	5. Crop husbandry activities are implemented based on the calendar.
 |
| 1. Establish a harvesting and postharvest processing schedule
 | * 1. Harvesting and ***Postharvest activities*** are established based on the types of crops
	2. A calendar of activities is prepared based on types of crops and crop growth cycle.
	3. Harvesting and postharvest activities are implemented based on the calendar.
 |

 **RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range**  |
| * Crop husbandry activities may include but not limited to
 | 1. Sowing
2. Transplanting
3. Crop protection
4. Fertilizer application
5. Weeding
6. Water application
 |
| * Postharvest activities may include but not limited to:
 | * Threshing
* Drying
* Cooling
* Milling
* Grading
* Sorting
* Packaging
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Problem solving
* Supervising
* Time management
* Occupational Safety and health
* First aid
* Surveying and Mapping
* Trouble shooting
* Reporting
* Record keeping
* Budgeting

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Instrumentation
* Technical specifications
* Statutory regulation
* Standard operating procedures
* Analytical methods
* Hydrology
* Crop science
* Technical specifications
* Statutory regulations
* Occupational health and safety
* Quality Assurance
* Standard operating procedures
* Irrigation water quality management
* Statistics
* Soil analysis methods
* Technical drawing
* Computer Aided drawing
* Plant-water requirements
* Agricultural tractors
* Entrepreneurship
* Marketing

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1.Critical aspects of Competency | Assessment requires that the candidate:* 1. Determined physical properties of soil based on U.S.D.A classification systems
	2. Determined chemical properties of soil based on U.S.D.A classification systems
	3. Determined biological properties of soil based on U.S.D.A classification systems
	4. Classified fertilizers based on their origin and nutrients they supply
	5. Identified methods of fertilizer application based on manufacturers specification
	6. Determined components of soil and plant water potential based on properties of the soil.
	7. Determined crop water requirements based on crops and weather
	8. Identified types and number of crops based on farmer preference.
	9. Divided the farm based on the type and number of crops identified.
	10. Prepared cropping calendar based on the market.
	11. Carried out planting based on the cropping calendar prepared.
	12. Identified crops based on farmer’s preference.
	13. Established crop husbandry activities based on the types of crops
	14. Prepared a calendar of activities based on types of crops and crop growth cycle.
	15. Implemented crop husbandry activities based on the calendar.
	16. Established harvesting and postharvest activities based on the types of crops
	17. Prepared a calendar of activities based on types of crops and crop growth cycle.
	18. Implemented harvesting and postharvest activities based on the calendar.
 |
| 1. 2.Resource Implications
 | The following resources **MUST** be provided: 1. Soil and water laboratories
2. Irrigation laboratory
3. Irrigation models
4. Irrigated farm
5. Farm machinery
6. Water quality laboratory
7. Models of farm implements
8. Soil water, plant relationship chart
9. Drainage models
 |
| 3.Methods of Assessment | Competency in this unit may be assessed through: 1. Observation
2. Oral Questioning
3. Written tests
4. Interview
5. Oral questions
6. Third party report
 |
| 1. 4. Context of Assessment
 | Competency may be assessed through:1. On–the–job
2. Off-the –job
3. Industrial attachment
 |
| 1. 5. Guidance information for assessment
 | Holistic assessment with other units relevant to the water sector, workplace and job role is recommended. |

## APPLY WATER RESOURCES MANAGEMENT PRINCIPLES

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

**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.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT** These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**These are assessable statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range.*** |
| 1. Determine hydrological Processes
 | 1. ***Precipitation types and forms*** are determined based on WMO guidelines
2. Precipitation evaporation and stream flow is determined based on the WMO guidelines
3. Safety in hydrometry is observed based on OSH
 |
| 1. Quantify surface water
 | 1. Sites for installation of hydrological instruments are identified based on WMO guidelines
2. ***Hydrological Instruments*** are installed based on WMO guidelines
3. ***Hydrological data*** is collected based on parameters to be measured
4. Hydrological data is analyzed and quantified based on the collected parameters
 |
| 1. Determine rock types and aquifers
 | 1. Rock types are determined based on their origin
2. Aquifer types are determined based International Association of Hydro-geologists (IAH) guidelines
 |
| 1. Establish suitable site for wells
 | 1. Suitable sites for wells are determined based groundwater potential
2. ***Suitable methods for well site establishment*** are selected based on user preference
3. Suitable well sites are established based on groundwater potential
4. Well hydraulics is determined based on hydrogeological survey and drilling report.
 |
| 1. Conserve Environment
 | * 1. Factors affecting water and soil conservation are determined based on natural and artificial activities.
	2. Water and soil conservation measures are applied based on the identified factors
	3. Types of land degradation and causes are identified based on environment
	4. Effects of land degradation are identified based on degradation types identified
	5. Control measures are applied based on the identified factors
 |
| 1. Develop water harvesting and storage structures
 | 1. ***Water harvesting and storage techniques*** are determined based on-site conditions
2. Suitable sites for ***water harvesting and storage structures*** are identified based on geological structures
3. Water harvesting and storage structures are designed based on the need
4. Simple water harvesting and storage structures are operated and maintained based on standard operating procedures
 |
| 1. Apply Water Resources Management Principles
 | * 1. Gender mainstreaming is adhered to base on IWRM principles
	2. Principles of management are applied based on water resources regulatory framework
 |

 **RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range**  |
| * Concepts of Hydrological cycle may include but not limited to:
 | * Evaporation
* Condensation
* Precipitation
* Transpiration
* Surface run-off
* Infiltration
* Percolation
 |
| * Precipitation types may include but not limited to:
 | * Orographic
* Convective
* Cyclonic
 |
| * Precipitation forms may include but not limited to:
 | * Rain
* Hail
* Sleet
* Drizzle
* Fog
* Mist
* Snow
 |
| * Hydrological Instruments may include but not limited to:
 | * Rain gauges
* Evaporation pans
* Current meters
 |
| * Hydrological data may include but not limited to:
 | * Rainfall data
* Evaporation data
* Stream flow data
 |
| * Rock types may include but not limited to:
 | * Igneous
* Metamorphic
* Sedimentary
 |
| * Aquifer types may include but not limited to:
 | * Confined
* Unconfined
* Perched
* Leaky
 |
| * Methods of well site establishment include but not limited to:
 | * Metallic rod pegs
* Hard wood pegs
* Concrete pegs
* Protected dug holes
 |
| * Water harvesting techniques include but not limited to:
 | * Rock catchment
* Roof catchment
* Surface water catchment
 |
| * Water harvesting and storage structures may include but not limited to:
 | * Small dams
* Water pans
* Ponds
* Man- made lakes
 |
| * Types of laws may include but not limited to:
 | * Criminal
* Civil
 |
| * Water laws may include but not limited to:
 | * Riparian
* Prior appropriation
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Applying fundamental operations (addition, subtraction, division, multiplication
* Logical thinking
* Problem solving
* Applying statistics
* Drawing graphs
* Using different measuring tools
* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Supervising
* Time management
* Technical skills:
* Reporting
	+ Mapping
	+ Data logging
	+ Data analysis
	+ Instrumentation
* First aid
* Performance appraising
* Record keeping
* Operation and maintenance

**Required knowledge**

The individual needs to demonstrate knowledge of:

* + Hydrology
	+ Hydrogeology
	+ Geology
	+ Meteorology
	+ Community development
	+ Instrumentation
	+ Technical specifications
	+ Statutory regulations
	+ Occupational health, safety
	+ Quality Assurance
	+ Standard operating procedures
	+ Analytical methods
	+ Statistics

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1.Critical aspects of Competency | Assessment requires that the candidate:* 1. Determined precipitation types and forms based on WMO guidelines
	2. Determined precipitation evaporation and streamflow based on the WMO guidelines
	3. Observed safety in hydrometry based on OSH
	4. Identified sites for installation of hydrological instruments based on WMO guidelines
	5. Installed hydrological Instruments based on WMO guidelines
	6. Collected hydrological data based on parameters to be measured
	7. Analyzed hydrological data and quantified based on the collected parameters
	8. Determined rock types and aquifers based on their formation and rock units
	9. Determined suitable sites for wells-based groundwater potential
	10. Selected Suitable methods for well site establishment based on user preference
	11. Established Suitable well sites based on groundwater potential
	12. Prepared well site establishment report based on Water Resource Management rules (WRM) 2007\*
	13. Water and soil conservation measures are applied based on the identified factors
	14. Applied Control measures based on the identified factors
	15. Determined Water harvesting and storage techniques based on site conditions
	16. Designed simple water harvesting and storage structures based on the need
	17. Operated and maintained Simple water harvesting structures based on standard operating procedures
	18. Applied Principles of WRM based on government regulatory framework
 |
| 1. 2.Resource Implications
 | The following resources should be provided: 1. Access to relevant workplace or appropriately simulated environment where assessment can take place
2. Measuring equipment
3. Materials relevant to the proposed activity or tasks
4. Geolab
5. Field equipment
6. Petrographic microscope
7. Hand lens
8. Clinometer
9. GPS receiver
10. Maps
11. Steel file / steel knife
12. Metal rod
 |
| 3.Methods of Assessment | Competency in this unit may be assessed through: 1. Direct Observation
2. Demonstration with Oral Questioning
3. Written tests
4. Interview
5. Oral questions
6. Third party report
 |
| 1. 4. Context of Assessment
 | Competency may be assessed through:1. On–the–job
2. Off-the –job
3. Industrial attachment
 |
| 1. 5. Guidance information for assessment
 | Holistic assessment with other units relevant to the water sector, workplace and job role is recommended. |

## APPLY PRINCIPLES OF FLUID MECHANICS

UNIT CODE: WAT/OS/IDET/CC/08/6A

**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.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Apply properties of fluids
 | 1. ***Properties of fluids*** are identified based on standards
2. Fluid properties are calculated based on type of fluid
3. Fluid properties are applied based on fluid mechanics
 |
| 1. Apply principles of pressure measurements
 | * 1. Fluid pressure is determined based on defined laws
	2. Devices for pressure measurement are used based on working principles
 |
| 1. Apply Principles of hydrostatic forces on surfaces principles
 | * 1. Hydrostatic force is determined based on type of surface and point of action
	2. Reaction of surfaces to pressure are determined based on hydrostatic forces
 |
| 1. Apply Principles of dynamics of fluid low
 | * 1. Behavior of fluid flow is determined based on motion formulae and theorems
	2. Fluid dynamics behavior is measured by devices
 |
| 1. Principles of fluid flow through pipes
 | * 1. Flow of fluid through pipe under pressure is analyzed based on formulae
	2. Pipeline design elements are determined based on fluid flow characteristics through pipe under pressure.
 |
| 1. Flow in open channels
 | * 1. Flow in open channels is classified based on the flow characteristics
	2. Open channel design elements are determined based on laws
 |
| 1. Apply principles of Hydraulic structures
 | * 1. Principles of operation of hydraulic structures is determined based on fluid flow dynamics
	2. ***Tools and equipment*** for measuring fluid flow dynamics are used based on fluid properties
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variables** | **Range**  |
| * Properties of fluids may include but not limited to:
 | * Density
* Specific weight
* Specific volume
* Specific gravity
* Viscosity
* Compressibility and bulk modulus
* Surface tension and capillarity
* Vapour pressure and cavitation
 |
| * Tools, equipment and facilities for hydraulics may include but not limited to:
 | * Manometers
* Venturimeters
* Pitot tubes
* Orifice meter
* Orifices
* V-notches
* Weirs
* Channels
* Hydraulic bench
 |
| * Hydraulics principles may include but not limited to:
 | * Hydrostatics
* Hydrodynamics
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Reporting
* Record keeping
* Problem solving
* Supervising
* Organizing
* Trouble shooting
* Time management
* Data logging

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Laboratory Safety
* Instrumentation
* Standard operating procedures
* Calibration
* Report writing

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills, knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:1. Calculated fluid properties based on standards
2. Applied fluid properties based on fluid mechanics
3. Determined fluid pressure based on defined laws
4. Used devices for measuring pressure based on working principles
5. Determined hydrostatic force based on type of surface and point of action
6. Determined reaction of surfaces to pressure based on hydrostatic forces
7. Determined behavior of fluid flow based on motion laws and theorems
8. Measured fluid dynamics behavior using measuring devices
9. Analyzed flow of fluid through pipe under pressure based on formulae
10. Determined Pipeline design elements based on fluid flow characteristics.
11. Classified flow in open channels based on the flow characteristics
12. Determined open channel design elements based on laws
13. Determined principles of operation of hydraulic structures is determined based on fluid flow dynamics
14. ***Tools and equipment*** for measuring fluid flow dynamics are used based on fluid properties
 |
| 1. Resource Implications
 | The following resources **must** be provided:1. Software
2. Hydraulics Laboratory
 |
| 1. Methods of Assessment
 | Competency may be assessed through:1. Written assessment
2. Oral interview
3. Observation
 |
| 1. Context of Assessment
 | Assessment may be done:1. On–the–job training
2. Coursework
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended |

## APPLY PRINCIPLES OF, SOIL MECHANICS

UNIT CODE: WAT/OS/IDET/CC/09/6A

**UNIT DESCRIPTION**

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

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Apply soil mechanics
 | * 1. ***Engineering properties of soils*** are identified based on the soil’s classification
	2. **Soil analysis tools, supplies and materials** are identified and gathered based on available resources and the tests to be conducted
	3. Engineering properties of soils are analyzed based on the standard procedures Soil analysis report is prepared based on the results.
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variables** | **Range**  |
| * Engineering properties of soils may include but not limited to:
 | * Index properties
* Cohesion
* Angle of internal friction
* Capillarity
* Permeability
* Elasticity
* Compressibility
 |
| * Soil analysis tools, supplies and materials may include but not limited to:
 | * Sieve analysis
* PI index
* Odometer tests
* Casagrande
* Cone penetrometer
* Sand replacement
* Moisture content
* California Bearing Ratio
* Proctor
* Triaxial test
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Reporting
* Record keeping
* Problem solving
* Supervising
* Organizing
* Trouble shooting
* Time management
* Data logging

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Laboratory Safety
* Instrumentation
* Standard operating procedures
* Calibration
* Report writing

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills, knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:1. Identified and gathered soil analysis tools, supplies and materials based on available resources and the tests to be conducted
2. Identified engineering properties of soils based on the soil’s classification
3. Analyzed properties of soils based on the standard procedures
4. Prepared soil analysis report based on the results.
 |
| 1. Resource Implications
 | The following resources **must** be provided:1. Soil mechanics laboratory
 |
| 1. Methods of Assessment
 | Competency may be assessed through:1. Written assessment
2. Oral interview
3. Observation
4. Design project
 |
| 1. Context of Assessment
 | Assessment may be done:1. On–the–job training
2. Coursework
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended |

## APPLY PRINCIPLES OF STRUCTURAL MECHANICS

UNIT CODE: WAT/OS/IDET/CC/10/6A

**UNIT DESCRIPTION**

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

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Apply structural mechanics principles
 | * 1. ***Properties of materials*** are identified based on job requirements
	2. ***Section properties*** of are analyzed based on the materials
	3. ***Structural elements*** are analyzed based on materials and loadings
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variables** | **Range**  |
| * Properties of material may include but not limited to:
 | * Stress
* Strain
* Elasticity
* Plasticity
* Stiffness
* Young’s modulus
 |
| * Section properties of materials may include but not limited to:
 | * Centroids
* Centre of gravity
* 1st moment of area
* 2nd moment of area
* Section modulus
* Radius of gyration
 |
| * Structural elements may include but not limited to:
 | * Reinforced Concrete Structures
* Beams
* Columns
* Floors
* Foundations
* Timber Structures
* Timber grading
* Stresses
* Struts
* Ties
* Purlins
* Joists
* Steel
* Welded joints
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Reporting
* Record keeping
* Problem solving
* Supervising
* Organizing
* Trouble shooting
* Time management
* Data logging

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Laboratory Safety
* Instrumentation
* Standard operating procedures
* Calibration
* Report writing

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills, knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:1. Identified properties of materials based on job requirements
2. Analyzed section properties based on the materials
3. Analysed structural elements based on materials and loadings
4. Identified structural elements based on the job requirement
 |
| 1. Resource Implications
 | The following resources **must** be provided:1. Computer room
2. Softwares
 |
| 1. Methods of Assessment
 | Competency may be assessed through:* Written assessment
* Oral interview
* Observation
 |
| 1. Context of Assessment
 | Assessment may be done:1. On–the–job
2. Off–the–job
3. Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended |

# CORE UNITS OF COMPETENCY

## DESIGN IRRIGATION AND DRAINAGE INFRASTRUCTURE

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

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.

This standard applies in Water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Conduct feasibility study
 | 1. Desktop study on irrigation resources is done based on Terms of Reference and legal guidelines.
2. Reconnaissance survey is done based on terms of reference.
3. A feasibility report is prepared based on the analysis of reconnaissance survey findings.
 |
| 1. Determine the required irrigation and drainage system components
 | 1. Feasibility report is interpreted based on the available ***irrigation and drainage technologies.***
2. Irrigation and drainage system is chosen based on the feasibility study findings, client’s preference and/or on capital.
3. ***Required irrigation and drainage components*** are determined based on the chosen system.
 |
| 1. Conduct site survey for irrigation and drainage infrastructure
 | 1. ***Survey tools and equipment*** are identified based on the site conditions and required data.
2. Survey plan is prepared based on design manual and FAO irrigation manuals.
3. Site survey is carried out based on site requirements.
4. Survey maps and Profiles are drawn based on design manual and FAO irrigation manuals
 |
| 1. Design irrigation and drainage infrastructure
 | 1. Irrigation water requirement is determined based on ***crop, water and soil properties.***
2. A scheme layout is developed based on the land topography and the ***source of water***.
3. ***Scheme components*** are sized based on the scheme layout, design guidelines and standards.
4. Scheme components are drawn based on the design.
5. Irrigation and drainage system bill of quantities is prepared based on the design.
6. Scheme report is prepared based on the design.
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| Variables | Range  |
| * Irrigation and drainage technologies may include but not limited to:
 | * Pressurized
* Surface
* Subsurface
* Green house and vertical gardens
* Aquaponics
* Hydroponics
* Drainage systems
* Flood based irrigation
 |
| * Irrigation and drainage components may include but not limited to:
 | * Abstraction structures
* Weirs
* Canals
* Drops
* Division boxes
* Chutes
* Siphons
* Culverts
* Pipes
* Flumes
* Pumping unit
* Valve chambers
* Filtration system
* Storage structures
* Fertigation systems
* Irrigation control units
* Soil Sensors
* Power sources for pumping systems
* Automation systems
 |
| * Crop,water and soil properties may include but not limited to:
 | * soil water holding capacity
* soil fertility
* chemical compositions
* crop water requirement
* Water quality
 |
| * Scheme components may include but not limited to:
 | * Offices
* Weather station
* Garage
* Training center
* Machinery shade
* Storage
* Irrigation fields
* Staff housing
* Water quality laboratory
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

**Generic skills:**

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Problem solving
* Supervising
* Time management
* Occupational Safety and health
* First aid

**Technical skills:**

* Surveying and Mapping
* Preparing irrigation and drainage report
* Trouble shooting
* Reporting
* Record keeping
* Operation and maintenance
* Preparing Bill of quantities
* Technical drawing
* Designing
* Environmental impact assessment (EIA)

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Instrumentation
* Technical specifications
* Statutory regulations
* Occupational health, safety
* Quality Assurance
* Water pollution
* Standard operating procedures
* Analytical methods
* Water quality assessment
* Statistics
* Remote sensing
* GIS
* IWRM
* Hydrology
* Soil science
* Crop science

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate1. Did desktop study on irrigation resources based on legal guidelines.
2. Did reconnaissance survey base on assignment instructions?
3. Prepared a feasibility report on the reconnaissance survey findings.
4. Interpreted feasibility report based on the available irrigation and drainage technologies.
5. Chose irrigation and drainage system based on the feasibility study findings, client’s preference and/or on capital.
6. Determined Irrigation and drainage components based on the chosen system.
7. Identified Survey tools and equipment based on the site conditions and the required data.
8. Prepared Survey plan based on GOK and FAO irrigation manuals.
9. Carried out Site survey based on site requirements.
10. Drew Survey maps and profiles based on GOK design manual and FAO irrigation manuals
11. Determined Irrigation water requirement based on crop and soil properties.
12. Developed a scheme layout based on the land topography and the source of water.
13. Sized scheme components based on the scheme layout and design guidelines and standards.
14. Drew scheme components based on the design.
15. Prepared irrigation and drainage system bill of quantities based on the design.
16. Prepared scheme design report based on the design
 |
| 1. Resource Implications
 | The following resources **must** be provided:1. Surveying equipment
2. Soil and water laboratories
3. Personal Protection Equipment (PPE)
4. Global Positioning System receiver (GPS)
5. Flow measurement and regulation devices (current meters, water level gauges)
6. Computers and softwares
7. Meteorological data
 |
| 1. Methods of Assessment
 | Competency may be assessed through:1. Written tests
2. Observation
3. Interview
4. Third party report
 |
| 1. Context of Assessment
 | Assessment may be done:1. On–the–job
2. Off-the –job
3. Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended |

## CONSTRUCT IRRIGATION AND DRAINAGE INFRASTRUCTURE

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

**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.

This standard applies in Water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Interpret irrigation and drainage infrastructure design drawings
 | 1. Ground truthing design drawings is carried out based on the field visit
2. Irrigation and drainage design are verified based on ground measurements
3. Availability of irrigation design components is established based on the design
 |
| 1. Set out irrigation and drainage infrastructure
 | 1. Site organization is carried out based on the magnitude of works
2. Human and machinery resources are mobilized based on scope of works
3. Field boundaries are established based on design
4. Bench mark is established based on the coordinates
5. Profile and longitudinal surveys are conducted based on the irrigation and drainage system structures
6. Irrigation and drainage system structures are marked on the ground based on the design
 |
| 1. Construct and install irrigation and drainage components
 | 1. An implementation schedule for construction is prepared based on the design
2. ***Construction materials and equipment*** is identified based on the design
3. ***Construction and installation works*** are carried out based on design
4. As build drawings and installations operation manuals are prepared and handed over based on actual works
5. Testing and commissioning the irrigation and drainage system is carried out based on the operation guidelines
 |
| 1. Manage construction works
 | * 1. Public participation is carried out based on legal framework
	2. Site meetings are conducted as per the implementation schedule
 |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| Variables | Range  |
| * Construction materials and equipment may include but not limited to:
 | Construction materials1. Cement
2. Sand
3. Ballast
4. Reinforcements
5. Timber
6. Water proofing chemicals

Equipment 1. Plant machinery
 |
| * Construction and installation worksmay include but not limited to:
 | * Construction works
	+ excavation
	+ concrete works
* Installation works
	+ pipeline network,
	+ pumping plant
	+ irrigation system components
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

**Generic skills:**

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Problem solving
* Supervising
* Time management
* Occupational Safety and health
* First aid

**Technical skills:**

* Surveying and Mapping
* Trouble shooting
* Building and construction
* Reporting
* Record keeping
* Operation and maintenance
* Interpretation of Bill of quantities
* Interpreting Technical drawings
* Plant operation

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Instrumentation
* Technical specifications
* Statutory regulations
* Occupational health, safety
* Quality Assurance
* Standard operating procedures
* Analytical methods
* Construction standards

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency
 | * 1. Assessment requires evidence that the candidate:
	2. Carried out ground truthing the irrigation and drainage design drawings based on the field visit
	3. Verified Irrigation and drainage design based on ground measurements
	4. 1Established availability of irrigation design components based on the design
	5. Established field boundaries based on design
	6. Established bench mark based on the coordinates
	7. Conducted profile and longitudinal surveys based on the irrigation and drainage system structures
	8. Marked irrigation and drainage system structures on the ground based on the design
	9. Prepared an implementation schedule for construction based on the design
	10. Identified construction materials and equipment based on the design
	11. Carried out construction and installation works based on design
	12. Carried out testing the irrigation and drainage system based on the operation guidelines.
 |
| 1. Resource Implications
 | The following resources **must** be provided:1. Surveying equipment
2. Soil mechanics laboratories
3. Construction equipment
4. Electrical mechanical laboratories
5. Construction workshops
6. Personal Protection gear
7. Irrigation
8. Global Positioning System receiver (GPS)
9. Hydraulics lab
10. water level recorders
11. notches
12. Computers and softwares
 |
| 1. Methods of Assessment
 | Competency may be assessed through:1. Written tests
2. Observation
3. Interview
4. Third party report
 |
| 1. Context of Assessment
 | Assessment may be done:1. On–the–job
2. Off-the –job
3. Industrial attachment
 |
| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended |

## OPERATE AND MAINTAIN IRRIGATION AND DRAINAGE SYSTEMS

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

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 system.

This standard applies in Water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**These are **assessable** statements which specify the required level of performance for each of the elements.***Bold and italicized terms are elaborated in the Range*** |
| 1. Develop a schedule for operation of irrigation and drainage system
 | 1. Water availability is assessed based on discharge measurements and forecast of rainfall.
2. Tentative cropping and water supply program is prepared based on the acreage and water availability.
3. Consultation with key stakeholders is made based on the prepared cropping and water supply program.
4. Final cropping and water supply program are prepared based on the consultations with the key stakeholder’s findings.
 |
| 1. Carry out routine operation activities
 | 1. ***Operation activities*** are identified based on irrigation technology.
2. Operation cost is determined based on the operation activities identified and acreage.
3. Operation activities are carried out based on the standard operational procedures.
 |
| 1. Inspect irrigation and drainage system
 | 1. An inspection plan for irrigation and drainage system is prepared based on the irrigation technology.
2. Inspection of the irrigation and drainage system is carried out based on the prepared plan.
3. An inspection report is prepared based on the inspection findings.
 |
| 1. Monitor performance of irrigation and drainage system
 | 1. Monitoring plan for performance of the irrigation and drainage system is prepared based on the irrigation technology and farm activities.
2. ***Performance data*** is collected based on the prepared monitoring plan
3. Collected data is analyzed based on ***evaluation criteria***
4. Conflicts are managed based on the causes
5. A monitoring report is prepared based on the evaluation findings
 |
| 1. Carry out routine maintenance of irrigation and drainage system
 | 1. Maintenance activities are identified based on irrigation technology
2. A schedule for maintenance of irrigation and drainage system developed based on based on the identified activities.
3. ***Maintenance activities*** for irrigation and drainage system are carried out based on the prepared schedule.
 |

RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| Variables | Range  |
| * Operation activities may include but not limited to:
 | * Land preparation
* Water supply
* Irrigation scheduling
 |
| * Performance data may include but not limited to:
 | * Total water supply
* Crop water supply
* Crop yield
* Pressure variation
 |
| * Evaluation criteria may include but not limited to:
 | * Crop productivity
* Water use efficiency
* Water conveyance efficiency
* Irrigation efficiency
 |
| * Maintenance activities may include but not limited to:
 | * Desilting of canals
* Road repair
* Repair and fabrication of gates and gauges
* Moulding and repair of road and canal crossings culverts
	+ drifts
	+ passages
* Repair and servicing of pumps and generators
* Repair of pipelines
	+ Filters
	+ Leaks
	+ valves
* Repair and servicing of machinery
	+ Ploughs
	+ farm machinery
	+ plant machinery
	+ motorbikes
* Repair of the drains
 |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

**Generic skills:**

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Problem solving
* Supervising
* Time management
* Occupational Safety and health
* First aid

**Technical skills:**

* Surveying and Mapping
* Trouble shooting
* Building and construction
* Reporting
* Record keeping
* Operation and maintenance
* Interpretation of Bill of quantities

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Instrumentation
* Technical specifications
* Occupational health, safety
* Quality Assurance
* Standard operating procedures
* Analytical methods
* Construction standards
* Hydrology
* Crop science
* Safety measures
* Technical specifications
* Irrigation water quality management
* Statistics
* Soil analysis methods
* Hydraulics skills
* Technical drawing
* Computer Aided drawing
* Plant-water requirements
* Agricultural practices
* Agricultural machinery

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

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| --- | --- |
| 1. Critical Aspects of Competency
 | Assessment requires evidence that the candidate:* 1. Assessed water availability based on discharge measurements and forecast of rainfall.
	2. Prepared tentative cropping and water supply program based on the acreage and water availability.
	3. Made consultation with key stakeholders based on the prepared cropping and water supply program.
	4. Prepared final cropping and water supply program based on the consultations with the key stakeholder’s findings.
	5. Identified operation activities based on irrigation technology.
	6. Determined operation cost based on the operation activities identified and acreage.
	7. Carried out operation activities based on the availability standard operation procedures.
	8. Prepared an inspection plan for irrigation and drainage system based on the irrigation technology.
	9. Carried out an inspection of the irrigation and drainage system based on the prepared plan.
	10. Prepared an inspection report based on the inspection findings.
	11. Prepared monitoring plan for performance of the irrigation and drainage system based on the irrigation technology and farm activities
	12. Managed Conflict based on the causes
	13. Collected performance data based on the prepared monitoring plan
	14. Analyzed collected data based on evaluation criteria
	15. Prepared a monitoring report based on the evaluation findings
	16. Identified maintenance activities based on irrigation technology
	17. Developed a schedule for maintenance of irrigation and drainage system based on the identified activities.
	18. Carried out maintenance activities for irrigation and drainage system based on the prepared schedule.
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| 1. Resource Implications
 | The following resources **should** be provided:1. Surveying equipment
2. Soil and water laboratories
3. Construction workshops
4. Personal Protection gear
5. Global Positioning System receiver (GPS)
6. Water level gauges
7. Rain gauges
8. Plumbing equipment
9. Concrete mixers
10. Vibrators
11. Welding equipment
12. Compactors
13. Generators
14. Farm machinery
15. Computers and softwares
 |
| 1. Methods of Assessment
 | Competency may be assessed through:1. Written tests
2. Observation
3. Interviews
4. Third party report
 |
| 1. Context of Assessment
 | Assessment may be done:1. On–the–job
2. Off-the –job
3. Industrial attachment
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| 1. Guidance information for assessment
 | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended |