

**REPUBLIC OF KENYA**

**NATIONAL OCCUPATIONAL STANDARDS**

**FOR**

**MECHANICAL TECHNOLOGY AND MAINTENANCE TECHNICIAN**

**LEVEL 6**



TVET CDACC

P.O BOX 15745-00100

NAIROBI

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# FOREWORD

The provision of quality education and training is fundamental to the

Government’s overall strategy for social economic development. Quality education and training will contribute to achievement 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 (Sessional Paper No. 4 of 2016). A key feature of this policy is the radical change in the design and delivery of the TVET training. This policy document requires that training in TVET be competency based, curriculum development be industry led, certification be based on demonstration of competence and mode of delivery allows for multiple entry and exit in TVET programs.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that these Occupational Standards were developed for the purpose of developing a competency based curriculum for Mechanical Technology and Maintenance Level 6. These Occupational Standards will also be the bases 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 Mechanical

Engineering sector’s growth and sustainable development.

**PRINCIPAL SECRETARY, VOCATIONAL AND TECHNICAL TRAINING MINISTRY OF EDUCATION**

# PREFACE

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

The Technical and Vocational Education and Training Act No. 29 of 2013 and the Sessional Paper No. 4 of 2016 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.

The TVET Curriculum Development, Assessment and Certification Council (TVET CDACC), in conjunction with Mechanical Engineering Sector Skills Advisory Committee (SSAC), have developed these Occupational Standards for a Mechanical Technology and Maintenance Technician. These occupational standards will be the bases for development of competency-based curriculum for Mechanical Technology and Maintenance Technician Level 6. These Standards will also be the bases for assessment of an individual for competence certification.

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

I am grateful to the Council Members, Council Secretariat, Mechanical engineering SSAC, expert workers and all those who participated in the development of these occupational standards.

**Prof. CHARLES M. M. ONDIEKI, PhD, FIET (K), Con. Eng Tech. CHAIRMAN, TVET CDACC**

# ACKNOWLEDGEMENT

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 the Mechanical Engineering 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.

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

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**CHAIRPERSON,**

**MECHANICAL ENGINEERING SECTOR SKILLS ADVISORY COMMITTEE**

# ACRONYMNS

B Version Control

CBET Competency Based Education and Training

CDACC Curriculum Development Assessment and Certification Council

CU Curriculum

DACUM Develop a Curriculum

EMCA Environmental Management and Conservation Act

KCSE Kenya Certificate of Secondary Education

KNQA Kenya National Qualifications Authority

MoEST Ministry of Education Science and Technology

NGO Non-Governmental Organization

NOS National Occupation Standard

OS Occupational Standard

OSH Occupational Safety and Health.

OSHA Occupation Safety and Health Act

PPE Personal Protective Equipment

RPL Recognition of Prior Learning

SSAC Sector Skills Advisory Committee

TVETA Technical and Vocational Education and Training Authority

# KEY TO UNIT CODE

**ENG/OS/MEM/BC/01/6/B**

Industry or sector

Occupational Standards

Occupational area

Type of competency

Competency number

Competency level

Control Version

# COURSE OVERVIEW

Certified Mechanical Technology and Maintenance Technician qualification consists of competencies that a person must achieve to enable him/her to perform Bench Work, Manual Metal Arc Welding, Gas welding and cutting, Lathe operations, equipment and machine maintenance and install machines and equipment.

The units of competency comprising certified Mechanical Technology and Maintenance Technician level VI qualification include the following basic, common and core competencies:

**BASIC UNITS OF COMPETENY**

1. Demonstrate communication skills
2. Demonstrate digital literacy
3. Demonstrate understanding of entrepreneurship
4. Demonstrate employability skills
5. Demonstrate environmental literacy
6. Demonstrate occupational safety and health practices

**COMMON UNITS OF COMPETENCY**

1. Prepare and interpret technical drawings
2. Apply engineering mathematics
3. Apply mechanical science principles
4. Apply fluid mechanics principles
5. Apply thermodynamics principles
6. Apply material science and perform metallurgical processes
7. Apply electrical principles

**CORE UNITS OF COMPETENCY**

1. Perform bench work operations
2. Perform manual metal arc welding
3. Perform oxy-acetylene gas welding and cutting
4. Perform lathe operations
5. Install machines and equipment
6. Perform equipment and machine maintenance
7. Maintain hydraulic and pneumatic systems
8. Maintain pumps and air compressors

# BASIC UNITS OF COMPETENCY

## DEMONSTRATE COMMUNICATION SKILLS

**UNIT CODE:** ENG/OS/MEM/BC/01/6/B

**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 met  1.2 Different approaches are used to meet communication needs of clients and colleagues  1.3 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 | * 1. When participating in internal or external forums, presentation is relevant, appropriately researched and presented in a manner to promote the organization   2. Presentation is clear and sequential and delivered within a predetermined time   3. Appropriate media is utilized to enhance presentation   4. Differences in views are respected   5. Written communication is consistent with organizational standards   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 |
| Interview situations include but not limited to: | * Establishing rapport * Eliciting facts and information * Facilitating resolution of issues * Developing action plans * Diffusing potentially difficult situations |
| 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 |

**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
* 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:** ENG/OS/MEM/BC/02/B

**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*** are identified ***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 built 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 includes 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 includes 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 includes but not limited to: | * Confidentiality of data * Cloud computing * Integrity -but-curious data surfing |
| Security and control measures includes but not limited to: | * Counter measures against cyber terrorism * Risk reduction * Cyber threat issues * Risk management * Pass-wording |
| Security threats includes but not limited to: | * Cyber terrorism * Hacking |
| Word processing concepts includes but not limited to: | Using a special program to create, edit and print documents |
| Network configuration includes 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:** ENG/OS/MEM/BC/03/B

**UNIT DESCRPTION**

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**

**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** |
| Strategic directions include but not limited to: | 1.1 Business continuity and succession  1.2 Resource access security  1.3 Core competencies development  1.4 New developments e.g. technological change, new products |
| Business/Corporate plan includes but not limited to: | 2.1 Action steps and responsibilities of departments and individual workers  2.2 Resource requirements and budget  2.3 Tactics and strategies to achieve objectives |
| Helpful mechanisms include but not limited to: | 3.1 Wage and non-wage benefits  3.2 Employee awards and recognition systems  3.3 Employee rights and welfare policies  3.4 Full-disclosure/transparency policies |

**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
* Managing operations/ production
* Using formal problem-solving procedures, e. g., root-cause analysis, six sigma
* Communication skills
* 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:

* Features and benefits of common operational practices, e. g., continuous improvement (kaizen), waste elimination,
* Conflict resolution
* Health, safety and environment (HSE) principles and requirements
* Public-relations strategies
* Basic cost-benefit analysis
* Basic financial management
* Business strategic planning
* Impact of change on individuals, groups and industries
* Employee assistance
* Government and regulatory processes
* Local and international market trends
* Product promotion strategies
* Mechanisms in the enterprise
* Market and feasibility studies
* Local and global supply chains Business models and strategies
* Government and regulatory processes
* Local and international business environment
* Concepts of change management
* Relevant developments in other industries
* Capital employed
* Regional/ County business expansion
* 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:  1.1 Demonstrated ability to maintain a profitable and stable enterprise as shown by stakeholder feedback, employee testimonies and company financial statements  1.2 Demonstrated ability to conceptualize and plan a micro/small enterprise  1.3 Demonstrated ability to manage/operate a micro/small-scale business  1.4 Demonstrated basic marketing skills |
| 2. Resource Implications | The following resources should be provided:   1. Interview guide for entrepreneurs 2. Enterprise workers and third parties 3. Materials and location relevant to the proposed activity and tasks |
| 3. Methods of Assessment | 1. Case problems 2. Interview 3. Portfolio 4. Third part reports |
| 4. 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:** ENG/OS/MEM/BC/04/B

**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.

|  |  |
| --- | --- |
| **Range** | **Variable** |
| 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:   * Oral Interview * Observation * Third Party Reports * 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:** ENG/OS/MEM/BC/06/B

**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. ***Storage methods*** for environmentally hazardous materials are strictly followed according to environmental regulations and OSHS.   2. ***Disposal methods*** of hazardous wastes are followed at all times according to environmental regulations and OSHS.   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 | * 1. Environmental legislations/conventions and local ordinances are identified according to the different environmental aspects/impact   2. Industrial standard/environmental practices are described according to the different environmental concerns |
| 1. Implement specific environmental programs | * 1. Programs/Activities are identified according to organizations policies and guidelines.   2. Individual roles/responsibilities are determined and performed based on the activities identified.   3. Problems/constraints encountered are resolved in accordance with organizations’ policies and guidelines   4. Stakeholders are consulted based on company guidelines |
| 1. Monitor activities on Environmental protection/Programs | * 1. Activities are periodically monitored and Evaluated according to the objectives of the environmental program   2. Feedback from stakeholders are gathered and considered in Proposing enhancements to the program based on consultations   3. Data gathered are analyzed based on Evaluation requirements   4. Recommendations are submitted based on the findings   5. Management support systems are set/established to sustain and enhance the program   6. Environmental incidents are monitored and reported to concerned/proper authorities |
| 1. Analyze resource use | * 1. All resource consuming processes are Identified   2. Quantity and nature of Resource consumed is determined   3. Resource flow is analyzed through different parts of the process.   4. Wastes are classified for possible source of resources. |
| 1. Develop resource conservation plans | * 1. Efficiency of use/conversion of resources is determined following industry protocol.   2. Causes of low efficiency of use of resources are determined based on industry protocol.   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.

|  |  |
| --- | --- |
| **Range** | **Variable** |
| PPEs include but are not limited to | * Mask * Gloves * Goggles * Safety hat * Overall * Hearing protector |
| Environmental pollution control measures include but are not limited to: | * Methods for minimizing or stopping spread and ingestion of airborne particle * Methods for minimizing or stopping spread and ingestion of gases and fumes * Methods for minimizing or stopping spread and ingestion of liquid wastes |
| Wastes include but are not limited to: | * Unnecessary waste * Necessary waste |
| Waste Management Procedures include but are not limited to: | * Sorting * Storing of items * Recycling of items * Disposal of items |
| Resources include but are not limited to: | * Electric * Water * Fuel * Telecommunications * Supplies * Materials |
| Workplace environmental hazards include but are not limited to: | * Biological hazards * Chemical and dust hazards * Physical hazards |
| Organizational systems and procedures include but are not limited to: | * Supply chain, procurement and purchasing * Quality assurance * Making recommendations and seeking approvals |
| Legislations/Conventions include but are not limited to: | * EMCA 1999 * Montreal Protocol * Kyoto Protocol |
| Environmental aspects/impacts 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 include but are not limited to: | * ISO standards * Company environmental management systems (EMS) |
| Periodic includes but are not limited to: | * hourly * daily * weekly * monthly * quarterly * yearly |
| Programs/Activities 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:** ENG/OS/MEM/BC/06/B

**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**

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| --- | --- |
| **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 identified  1.2 ***Evaluation and/or work environment*** measurements of OSH hazards/risk existing in the workplace is conducted by  Authorized personnel or agency  1.3 ***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 implemented  2.2 ***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 provided  3.2 Implementation of OSH procedures and policies/ guidelines are participated  3.3 Team members are trained and advised on OSH standards and procedures  3.4 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 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, gasses, vapors * 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 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 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 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 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) 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 include but are not limited to: | * Evacuation * Isolation * Decontamination * (Calling designed) emergency personnel |
| Emergency procedures 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 include but are not limited to: | * Chemical spills * Equipment/vehicle accidents * Explosion * Fire * Gas leak * Injury to personnel * Structural collapse * Toxic and/or flammable vapours emission. |
| OSH-related Records include but are not limited to: | * Science/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 counselling 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 location  2.2 OSH personal records  2.3 PPE  2.4 Health records |
| 1. Methods of Assessment | Competency may be assessed through:  3.1 Portfolio Assessment  3.2 Interview  3.3 Case Study/Situation  3.4 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

## PREPARE AND INTERPRET TECHNICAL DRAWINGS

**UNIT CODE:** ENG/OS/MEM/CC/01/6/B

**UNIT DESCRIPTION**

This unit covers the competencies required to prepare and interpret technical drawings. It involves competencies to select, use and maintain drawing equipment and materials. It also involves producing plane geometry drawings, solid geometry drawings, orthographic and pictorial drawings and applying CAD packages in drawing.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make the workplace function. | **PERFORMANCE CRITERIA**  These are assessable statements which specify therequired 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 requirements  1.2 ***Drawing materials*** are identified and gathered according to task requirements  1.3 Drawing equipment are used and maintained as per manufacturer’s instructions  1.4 Drawing materials are used as per workplace procedures  1.5 Waste materials are disposed in accordance with workplace procedures and ***environmental legislations***  1.6 ***Personal Protective Equipment*** is used according to the current OSHA rules and guidelines. |
| 2. Produce plane geometry drawings | 2.1 Different types of lines used in drawing and their meanings are identified according to standard drawing conventions  2.2 Different types of ***geometric forms*** are constructed according to standard drawing conventions  2.3 Different types of angles are constructed according to principles of trigonometry  2.4 Different types of angles are measured using appropriate measuring tools  2.5 Angles are bisected according to standard drawing conventions |
| 3. Produce solid geometry drawings | 3.1 Drawings of patterns are interpreted according to standard conventions  3.2 Patterns are developed in accordance with standard conventions |
| 4. Produce orthographic and pictorial drawings of components | 4.1 Different symbols and abbreviations are identified and their meaning interpreted according to standard drawing conventions  4.2 Isometric sketches and drawings of components are interpreted and produced in accordance with the standard conventions of isometric drawings  4.3 First and third angle orthographic sketches and drawings of components are interpreted and produced in accordance with the standard conventions of orthographic drawings  4.4 Freehand sketching of different types of geometric forms, tools, equipment, diagrams and components is conducted |
| 5. Produce assembly drawings | 5.1 Orthographic views are exploded according to standard conventions of orthographic drawings.  5.2 Pictorial views are exploded according to standard conventions of orthographic drawings.  5.3 Parts list are identified according to part to be produced  5.4 Sectional views are produced according to standard conventions of drawing.  5.5 Produced drawing is hatched according to standard conventions of drawings. |
| 1. Apply CAD packages in drawing | 1. CAD packages are selected according to task requirements.   CAD packages are applied in production of engineering 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** |
| Drawing equipment may include but not limited to: | * Drawing boards * T-square * Set squares * Drawing set * Computer and relevant software |
| Drawing materials may include but not limited to: | * Drawing papers * Pencils * Erasers * Masking tapes * Paper clips |
| Environmental legislations may include but not limited to: | * EMCA 1999 |
| Personal Protective Equipment may include but not limited to: | * Dust coats * Closed leather shoes * Goggles |
| Geometric forms may include but not limited to: | * Circles * Triangles * Rectangles * Parallelogram * Polygons * Pyramids * Conic sections * Prisms * Loci |
| Standard drawing conventions may include but not limited to: | * Anatomy of engineering drawing   + (title block, coordinate grid system, revision block, notes and legends) * Drawing scale (paper size and drawing symbols) * International drawing standards |

**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
* Drawing
* Interpretation
* Drawing equipment handling
* Analysis and synthesis
* Communication
* 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. Applied and adhered to safety procedures 2. Cared and maintained drawing equipment 3. Interpreted circuit, assembly and lay out diagrams 4. Applied appropriate technical standards, used proper tools and equipment for a given task 5. Produced sketches and drawings |
| 2. Resource Implications | Resources the same as that of workplace are advised to be applied.   1. Drawing room 2. Drawing equipment and materials |
| 3. Methods of  Assessment | Competency may be assessed through:   1. Practical tests 2. Observation |
| 4. Context of  Assessment | Competency may be assessed individually in the actual workplace or a simulated work place setting. |
| 5. 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: ENG/MEM/CC/02/6/B**

**UNIT DESCRIPTION:**

This unit describes the competencies required by a technician in order to apply algebra apply trigonometry and hyperbolic functions, apply complex numbers, apply coordinate geometry, carry out binomial expansion, apply calculus, solve ordinary differential equations, carry out mensuration, apply power series, apply statistics, apply numerical methods, apply vector theory and apply matrix.

**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 | 1.1 Calculations involving Indices are performed as per the concept  1.2 Calculations involving Logarithms are performed as per the concept  1.3 Scientific calculator is used in solving mathematical problems in line with manufacturer’s manual  1.4 Simultaneous equations are performed as per the rules  1.5 Quadratic equations are calculated as per the concept |
| 2. Apply Trigonometry and hyperbolic  functions | 2.1 Calculations are performed using trigonometric rules  2.2 Calculations are performed using hyperbolic functions |
| 3. Apply complex numbers | 3.1 Complex numbers are represented using Argand diagrams  3.2 Operations involving complex numbers are performed  3.3 Calculations involving complex numbers are performed using De Moivre’s theorem |
| 4. Apply Coordinate Geometry | 4.1 Polar equations are calculated using coordinate geometry  4.2 Graphs of given polar equations are drawn using the Cartesian plane  4.3 Normal and tangents are determined using coordinate geometry |
| 5. Carry out Binomial Expansion | 5.1 Roots of numbers are determined using binomial theorem  5.2 Errors of small changes are determined using binomial theorem |
| 6. Apply Calculus | 6.1 Derivatives of functions are determined using Differentiation  6.2 Derivatives of hyperbolic functions are determined using Differentiation  6.3 Derivatives of inverse trigonometric functions are determined using Differentiation  6.4 Rate of change and small change are determined using Differentiation.  6.5 Calculation involving stationery points of functions of two variables are performed using differentiation.  6.6 Integrals of algebraic functions are determined using integration |
| 7. Solve Ordinary differential equations | 7.1 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 |
| 8. Carry out Mensuration | 8.1 Perimeter and areas of figures are obtained  8.2 Volume and of Surface area of solids are obtained  8.3 Area of irregular figures are obtained  8.4 Areas and volumes are obtained using Pappus theorem |
| 9. Apply Power Series | 9.1 Power series are obtained using Taylor’s Theorem  9.2 Power series are obtained using  Maclaurin’s theorem |
| 10. Apply Statistics | 10.1 Mean, median, mode and standard deviation is obtained from given data  10.2 Calculations are performed based on Laws of probability  10.3 Calculations involving probability distributions, mathematical expectation, sampling distributions are performed  10.4Sampling distribution methods are applied in data analysis  10.5 Calculations involving use of standard normal table, sampling distribution, T-distribution and estimation are done  10.6 Confidence intervals are determined |
| 11. Apply Numerical methods | 11.1 Roots of polynomials are obtained using iterative ***numerical methods***  11.2 Interpolation and extrapolation are performed using numerical methods |
| 12. Apply Vector theory | 12.1 Vectors and scalar quantities are obtained in two and three dimensions  12.2 *Operations* on vectors are performed  12.3 Position of vectors is obtained  12.4 Resolution of vectors is done |
| 13. Apply Matrix | 13.1Determinant and inverse of 3x3 matrix are obtained  13.2Solutions of simultaneous equations are obtained  13.3Calculation 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** |
| Operations may 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 |
| 4. 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:

* Applying fundamental operations (addition, subtraction, division, multiplication)
* Using and applying mathematical formulas
* Logical thinking
* Problem solving
* Applying statistics
* Drawing graphs
* Using different measuring tools

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Fundamental operations (addition, subtraction, division, multiplication)
* Calculating area and volume
* Types and purpose of measuring instruments
* Units of measurement and abbreviations
* Rounding techniques
* Types of fractions
* Types of tables and graphs
* Presentation of data in tables and graphs
* Vector operations
* Matrix operations

**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 Trigonometry and hyperbolic functions 2. Applied complex numbers 3. Applied Calculus 4. Solved Ordinary differential equations 5. Carried out mensuration 6. Applied Power Series 7. Applied Vector theory 8. Applied Matrix 9. Applied Numerical methods |
| 2. Resource Implications | The following resources should be |
|  | provided:  2.1 Access to relevant workplace or appropriately simulated environment where assessment can take place  2.2 Measuring equipment  2.3 Materials relevant to the proposed activity or tasks |
| 3. Methods of Assessment | Competency in this unit may be assessed through:  1.1 Direct Observation  1.2 Demonstration with Oral Questioning  1.3 Written tests |
| 4. Context of Assessment | Competency may be assessed individually in the actual workplace or through accredited institution |
| 5. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY MECHANICAL SCIENCE PRINCIPLES

**UNIT CODE: ENG/OS/MEM/CC/03/06/B**

**UNIT DESCRIPTION**

This unit describes the competencies required by a technician in order to apply a wide range of Mechanical science principles in their work. It includes determining forces in a system, demonstrating knowledge of moments, understanding friction principles, understanding motions in engineering, describing work, energy and power, performing machine calculations, demonstrating gas principles, applying heat knowledge, applying density knowledge and applying pressure principles.

**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 forces in a system | 1.1 Forces are defined and described  1.2 ***Forces theorems*** are described  1.3 Resultant of coplanar forces are determined. |
| 2. Demonstrate knowledge of moments | 2.1 Moments are defined  2.2 Moments are calculated  2.3 Principles of moments are described  2.4 Couples are identified and applied in engineering systems. |
| 3. Demonstrate understanding of friction principles | 3.1 Laws of friction are identified  3.2 Limiting friction is calculated  3.3 Forces applied at an angle to a horizontal plane are calculated  3.4 Coefficient of friction is calculated  3.5 Advantages and disadvantages of friction are identified |
| 4. Demonstrate understanding of motions in engineering | 4.1 Motion concepts are discussed  4.2 Laws of motion are identified  4.3 Motion calculations are performed  4.4 Displacement/time graphs are applied |
| 5. Determine work, energy and power | 5.1 Work is calculated  5.2 Energy is calculated  5.3 Power calculations are performed |

|  |  |
| --- | --- |
| 6. Perform machine calculations | 6.1 ***Problems on simple machines*** are solved  6.2 Problems on levers are solved  6.3 Laws of machines are identified |
| 7. Demonstrate understanding of gas principles | 7.1 Gas laws are identified  7.2 Gas laws are applied in solving engineering problems  7.3 Uses of gases in engineering systems are identified |
| 8. Apply heat principles | 8.1 Heat concepts are discussed  8.2 Working principle of heat is defined  8.3 Heat capacity is discussed  8.4 Heat problems are solved |
| 9. Apply density principles | 9.1 Density terminology are discussed  9.2 Density measurements are carried out  9.3 Density problems are solved |
| 10. Apply pressure principles | 10.1 Pressure concepts are discussed  10.2 Working principles of pressure is discussed  10.3 Pressure problems are solved  10.4 Pressure applications are identified |

**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** |
| Forces theorems may include but not limited to: | * Parallelogram * Triangle * Polygon |
| Problems on simple machines may include but not limited to: | * Machine advantage * Velocity ratio * Efficiency |
| Gas laws may include but not limited to: | * Boyles law * Charles law * Gas equation |
| Density terminology may include but not limited to: | * Density * Relative density |
| Pressure applications may include but not limited to: | * Vacuum pump * Hydraulic pump * Hydrometers |
| Principles may include but not limited to: | * Newton’s laws of motion * Law of conservation of linear momentum * Law of conservation of energy * Archimedes’ principle |
| Mechanical calculations may include but not limited to: | * Mechanical advantage * Efficiency * Torque * Power/Energy * Work done |
| Laws of fluids may include but not limited to: | * Pascal’s principle * Gas laws |

**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:

* Apply basic mechanical formulas
* Use of basic mechanical machines
* Perform various unit conversions of mechanical quantities
* Basic mechanical systems design
* Mechanical machine operation
* Logical thinking
* Problem solving
* Applying statistics
* Drawing graphs
* Using different measuring tools

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Newton’s law
* Levers
* Gear trains
* Laws of conservation of energy
* Laws of friction
* Type of forces
* Thermodynamics
* Calculation of fluid pressure and flow rate
* Mechanical advantage and efficiency calculations
* Properties of materials
* Gas laws
* SI units of mechanical energy.
* Power transmission systems
* Parameters of fluid system
* Operation of mechanical machines
* Mechanical calculation of power, energy, work done, torque and safety factor
* Units of measurement, conversions and abbreviations

**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. Determined forces in a system 2. Demonstrated knowledge of moments 3. Understood friction principles 4. Understood motions in engineering 5. Described work, energy and power 6. Performed machine calculations 7. Demonstrated gas principles 8. Applied heat knowledge 9. Applied density knowledge 10. Applied pressure principles |
| 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 tools and equipment 3. Sample materials to be tested |
| 3. Methods of Assessment | Competency in this unit may be assessed through:   1. Direct Observation 2. Demonstration with Oral Questioning 3. Case studies 4. Written tests |
| 4. Context of  Assessment | Competency may be assessed individually in the actual workplace or through accredited institution |
| 5. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY FLUID MECHANICS PRINCIPLES

**UNIT CODE: ENG/OS/MEM/CC/04/6/B**

**UNIT DESCRIPTION**

This unit describes the competencies required by a technician in order to apply a wide range of fluid mechanics principles in their work. It includes understanding flow of fluids, demonstrating knowledge in viscous flow, performing dimensional analysis and operating fluid pumps

**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 flow in fluids | 1.1 Flow rate of fluids is measured  1.2 Losses in pipes are determined  1.3 ***Causes of losses*** in pipes are determined  1.4 Flow losses equations are applied in problem solving |
| 2. Demonstrate knowledge in viscous flow | 2.1 Viscous flow between parallel surfaces are explained  2.2 Viscous flow equations between parallel surfaces are derived and applied  2.3 Viscous flow equations in circular pipes are derived and applied in problem solving |
| 3. Perform dimensional analysis | 3.1 Dimensional analysis is explained  3.2 Principle of dimensional homogeneity is explained  3.3 Fundamental dimensions are stated  3.4 Dimensional units are defined  3.5 Physical quantities are identified  3.6 Dimensional analysis are applied in problem solving |
| 4. Operate fluid  pumps | 4.1 Principle of operation of pumps is described  4.2 Reciprocating pump equation is derived  4.3 Centrifugal pump equation is derived  4.4 Pump equations are applied in problem solving |

**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** |
| Causes of losses may include but not limited to: | * Friction * Enlargement/reduction in cross-sectional areas |
| Physical quantities may include but not limited to: | * Mass * Force * Density * Velocity * Acceleration |
| Applied may include but not limited to: | * Reynolds number * Mach number * Froude number |
| Principle of operation may include but not limited to: | * Reciprocating * Centrifugal |
| Reciprocating pump equation is derived may include but not limited to: | * Coefficient of discharge * Percentage slip * Work done * Acceleration head * Pressure head in the cylinder |
| Centrifugal pump equation is derived may include but not limited to: | * Effective head * Monomeric head * Monomeric efficiency * Mechanical efficiency * Discharge * Torque * Work done unit weight * Specific speed |

**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:

* Apply basic mechanical formulas
* Use of basic mechanical machines
* Perform various unit conversions of mechanical quantities
* Basic mechanical systems design
* Mechanical machine operation
* Logical thinking
* Problem solving
* Applying statistics
* Drawing graphs
* Using different measuring tools

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Newton’s law
* Levers
* Gear trains
* Laws of conservation of energy
* Laws of friction
* Type of forces
* Thermodynamics
* Calculation of fluid pressure and flow rate
* Mechanical advantage and efficiency calculations
* Gas laws
* SI units of mechanical energy.
* Power transmission systems
* Parameters of fluid system
* Operation of mechanical machines
* Mechanical calculation of power, energy, work done, torque and safety factor
* Units of measurement, conversions and abbreviations

**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 Principles of mechanical science 2. Performed mechanical calculations of a system 3. Identified types of forces on a system 4. Calculated resultant forces on plane framework 5. Identified application of forces on the production flow 6. Tested mechanical properties of a materials |
|  | | 1. Identified tools and equipment for measuring system parameters 2. Recorded and interpreted measured parameters. 3. Operated Power transmission systems |
| 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 tools and equipment 3. Sample materials to be tested |
| 1. Methods of Assessment | | Competency in this unit may be assessed through:   1. Direct Observation 2. Demonstration with Oral Questioning 3. Case studies 4. Written tests |
| 4. Context of  Assessment | | Competency may be assessed individually in the actual workplace or through accredited institution |
| 5. Guidance information for assessment | | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY THERMODYNAMICS PRINCIPLES

**UNIT CODE: ENG/OS/MEM/CC/05/06/B**

**UNIT DESCRIPTION**

This unit describes the competencies required by a technician in order to apply thermodynamics principles in their work. It includes understanding fundamentals of thermodynamics, performing steady flow processes, performing non steady flow processes, understanding perfect gases, generating steam, performing thermodynamics reversibility and entropy, understanding idea gas cycle, demonstrating fuel and combustion, perform heat transfer, understanding heat exchangers, understanding air compressors, understanding gas turbines and understanding of impulse steam turbines

**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 fundamentals of thermodynamics | 1.1 Terms used in thermodynamics are described  1.2 Thermodynamics processes and cycles are described  1.3 First law of thermodynamics is applied |
| 2. Demonstrate understanding of steady flow processes | 2.1 Steady flow energy equation is derived  2.2 Steady flow energy equation is applied in problem solving  2.3 Steady flow energy equation is applied in ***utilities*** |
| 3. Demonstrate understanding of non-steady flow processes | 3.1 Non-flow energy equation is derived  3.2 Non-flow energy equation is applied in problem solving |
| 4. Demonstrate understanding of perfect gases | 4.1 ***Perfect gas laws*** are stated  4.2 Gas laws experiment are carried out  4.3 Gas laws are applied |
| 5. Demonstrate understanding of steam generation | 5.1 Dryness fraction is determined  5.2 Relationship between pressure and boiling point is determined  5.3 Energy balance is carried out  5.4 Relationship between temperature and pressure is determined. |
| 6. Perform thermodynamics reversibility and entropy | 6.1 Thermodynamics reversibility is explained  6.2 Principles of heat engine are explained  6.3 Second law of thermodynamics is applied  6.4 Entropy is explained in thermodynamics cycle |
| 7. Demonstrate understanding of ideal gas cycles | 7.1 Ideal gas cycle processes are explained  7.2 Air standard efficiency and actual efficiency are differentiated  7.3 Problems are solved in ideal gas cycle |
| 8. Demonstrate understanding of fuel and combustion | 8.1 Fuels are classified  8.2 Properties of fuels are described  8.3 Combustion equation are derived  8.4 Combustion equation is applied to combustion and exhaust gas problems |
| 9. Demonstrate understanding of heat transfer | 9.1 Conduction equation is derived and applied from Fourier’s law  9.2 Heat transfer equation is derived and applied from Newton’s law of cooling and Fourier’s law |
| 10. Demonstrate understanding of heat exchangers | 10.1 Heat exchangers are classified 10.2 Recuperative heat exchangers are described  10.3 Heat equations are applied to solve heat exchanger problems |
| 11. Demonstrate understanding of air compressors | 11.1 Air compressors are classified 11.2 Types of air compressors are described  11.3 Equations of reciprocating compressors are derived and applied |
| 12. Demonstrate understanding of gas turbines | 12.1 Theoretical cycle for gas turbines is explained  12.2 Open cycle gas turbine is described  12.3 Closed cycle gas turbine is described  12.4 Gas turbine equations are derived and applied |
| 13.Demonstrate understanding of impulse steam turbines | 13.1 ***Principles of operations*** of the impulse steamturbines is described  13.2 Impulse steam turbine equation is derived and applied |

**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** |
| Utilities may include but not limited to: | * Boilers * Condensers * Compressors * Nozzles * Throttling processes |
| Perfect gas laws may include but not limited to: | * Boyle’s law * Charles’s law * Joule’s law |
| Principles may include but not limited to: | * Newton’s laws of motion * Law of conservation of linear momentum * Law of conservation of energy * Archimedes’ principle |
| Types of air compressors may include but not limited to: | * Reciprocating * Blowers * Sliding valves |
| Types of air compressors may include but not limited to: | * Compounding * Multistage impulse turbine |

**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:

* Apply basic mechanical formulas
* Use of basic mechanical machines
* Perform various unit conversions of mechanical quantities
* Basic mechanical systems design
* Mechanical machine operation
* Logical thinking
* Problem solving
* Applying statistics
* Drawing graphs
* Using different measuring tools

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Newton’s law
* Levers
* Gear trains
* Laws of conservation of energy
* Laws of friction
* Type of forces
* Thermodynamics
* Calculation of fluid pressure and flow rate
* Mechanical advantage and efficiency calculations
* Gas laws
* SI units of mechanical energy.
* Power transmission systems
* Parameters of fluid system
* Operation of mechanical machines
* Mechanical calculation of power, energy, work done, torque and safety factor
* Units of measurement, conversions and abbreviations

**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 Principles of mechanical science 2. Performed mechanical calculations of a system 3. Identified types of forces on a system 4. Calculated resultant forces on plane framework 5. Identified application of forces on the production flow 6. Tested mechanical properties of a materials 7. Identified tools and equipment for measuring system parameters 8. Recorded and interpreted measured parameters. 9. Operated Power transmission systems |
| 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 tools and equipment 3. Sample materials to be tested |
| 3. Methods of Assessment | Competency in this unit may be assessed through:   1. Direct Observation 2. Demonstration with Oral Questioning 3. Case studies 4. Written tests |
| 4. Context of assessment | Competency may be assessed individually in the actual workplace or through accredited institution |
| 5. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY MATERIAL SCIENCE AND METALLURGICAL PROCESSES

**UNIT CODE: ENG/OS/MEM/CC/06/6/B**

**UNIT DESCRIPTION:**

The learner will be introduced to performing material testing and metallurgical processes. It involves analyzing properties of engineering materials, understanding extraction, production of ferrous materials, ceramics, composites and alloys processes, performing heat treatment, material testing and prevention ofcorrosion in materials.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the keyoutcomes which make upworkplace 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 properties of engineering materials | 1.1 Type of engineering materials is identified as per the procedures  1.2 ***Physical properties*** of engineering materials are identified  1.3 ***Mechanical properties*** of engineering materials are identified  1.4 Crystal structure of materials are identified |
| 2. Demonstrate understanding of ore extraction processes | 2.1 Safety procedures are observed according OSHA  2.2 Method of extraction is determined as per material properties and its composition  2.3 Procedure in extraction process is determined as per extraction method  2.4 Extraction bi- products are stored as per SOPs  2.5 Extraction bi- products are disposed as per SOPs |
| 3. Demonstrate understanding of Production of ferrous materials | 3.1 Perform ore smelting according to standard operating procedures.  3.2 ***Composition of iron*** is determined  3.3 Method of producing ***iron material*** is established  3.4 Refinement processes are identified based on iron material required |
| 4. Demonstrate understanding of production of non-ferrous materials | 4.1 **Non-ferrous materials** are extracted according to SOP  4.2 Extracted non-ferrous material is smelted and purified as per the SOP  4.3 Non-ferrous material is tested according to SOP |
| 5. Demonstrate understanding of alloys | 5.1 Materials in alloy formation are identified  5.2 Alloy formation process is identified based on alloy to be produced  5.3 Alloy is tested based on alloy production requirement  4.4 Alloying elements for nonferrous materials are identified  5.5 Alloy formation process is identified based on alloy to be produced  5.6 Alloys for non-ferrous material are tested based on production requirement |
| 6. Demonstrate understanding of production of ceramics | 6.1 Composition of **ceramic materials** is identified  6.2 Manufacturing process is identified  6.3 Ceramic materials are produced according to manufacturing processes  6.4 ***Finishing processes*** are identified |
| 7. Demonstrate understanding of composite materials production | 7.1 Type of composite to be produced is identified  7.2 Elements involve in composite formation are identified  7.3 Formation process of composite to be produced is identified  7.4 Composite is tested as per composite production requirement |
| 8. Demonstrate understanding of heat treatment processes | 8.1 Safety practices are observed according to OSHA 2007  8.2 **Heat treatment processes** are identified  8.3 Procedure in heat treatment processes  8.4 Heat treatment of metals are performed |
| 9. Perform material testing | 9.1 Safety is observed in material testing procedures  9.2 **Material testing methods** are identified depending on material  to be tested  9.3 Procedure of material testing is followed as per material testing method  9.4 Material testing results are tabulated, calculated and interpreted  9.5 Material testing equipment are taken care of and maintained. |
| 10.Prevent material corrosion | 10.1 Safety is observed during corrosion  10.2 Corrosion type is identified  10.3 Corrosive atmosphere is identified  10.4 Methods of corrosion prevention are identified  10.5 Corrosion is prevented |

**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** |
| Physical properties may include but not limited to: | * Density * Color * Texture * Melting point * Thermo conductivity * Electrical resistivity |
| Mechanical properties may include but not limited to: | * Ductility * Malleability * Elasticity * Toughness * Hardness * Brittleness * Elasticity * Strength |
| Composition of iron may include but not limited to: | * Iron (II) oxide * Iron (III) oxide |
| Iron materials may include but not limited to: | * Cast iron * Steel |
| Non-ferrous materials may include but not limited to: | * Aluminum * Copper |
| Ceramic materials may include but not limited to: | * Oxides * Nitrides * Carbides * Silica |
| Finishing processes may include but not limited to: | * Lapping * Fine grinding * Polishing |
| Other engineering materials may include but not limited to: | * Rubber * Plastics * Wood * Glass |
| Corrosion type may include but not limited to: | * Galvanic * Stress corrosion cracking |
| Methods of corrosion prevention may include but not limited to: | * Painting * Electroplating * Galvanizing * Cathodic * Chromizing |

**REQUIRED KNOWLEDGE AND SKILLS**

The individual needs to demonstrate the following skills

**Required Skills**

* Measuring and marking
* Material testing
* Use of hand tools
* Inspection and testing

**REQUIRED KNOWLEDGE AND UNDERSTANDING**

The individual needs to demonstrate knowledge and understanding of:

* Occupational Health and Safety Act of Kenya laws 2007 with focus on personal safety, machine safety and workplace
* National Environment Management Authority Act, Kenya 2004
* OSH ACT 2007
* Equipment manuals
* Mathematics & science
* Physics and mechanics
* Metallurgy and materials
* Inspection and testing
* WIBA ACT
* Report writing

**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 learner   1. Observed safety as per work place procedures 2. Demonstrated understanding of physical, chemical and mechanical properties of engineering materials 3. Performed extraction processes 4. Produced iron materials 5. Produced ceramics 6. Produced composites 7. Produced alloys 8. Performed heat treatment 9. Performed material testing 10. Demonstrated understanding of corrosion types and its prevention |
| 2. Resource Implications | 1. Testing materials 2. Extraction materials 3. Measuring instruments 4. Inspection tools 5. Material testing equipment 6. Heat treatment equipment (furnace) |
| 3. Methods of  Assessment | Competency may be accessed through:   1. The behavior of the learner in the working environment 2. Inspection of finished product 3. Process analysis |
| 4. Context of  Assessment | Competency may be assessed individually in the actual workplace or through accredited institution |
| 5. Guidance information for assessment | Holistic assessment of other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY ELECTRICAL PRINCIPLES

**UNIT CODE:** ENG/OS/MEM/CC/07/6/B

**UNIT DESCRIPTION**

This unit describes the competencies required by a technician in order to apply a wide range of Electrical principles in their work; use the concept of basic Electrical quantities, use the concepts of D.C and A.C circuits in electrical installation, use of basic electrical machine, use of earthing in Electrical installations and apply lightning protection measures

**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 the concept of basic Electrical quantities | * 1. Basic ***SI unit***s in Electrical are identified   2. ***Quantities*** of Charge, current, resistance, voltage and power are identified   3. Perform calculations involving Ohm’s law i.e Current, Resistance and voltage   4. Calculations involving various electrical quantities are performed   5. Electrical quantities measuring instruments are identified |
| * + 1. Use the concepts of D.C and A.C circuits in electrical installation | * 1. Calculations involving parallel and series circuits are performed   2. Calculations involving Network theorems are performed. E.g. Kirchoff’s laws, Superposition, Thevinin’s, Norton’s   3. Photovoltaic solar system is identified   4. AC to DC and DC to AC conversion is performed |
| 1. Use basic electrical machine | * 1. Types of various electrical machines are identified   2. Operations involving single phase and three phase AC and DC Motors are performed   3. Calculations involving single and three phase AC and DC transformers are performed   4. Operations involving single and three phase generators are performed   5. AC and DC machines are applied as per their functions |
| 1. Use earthing in Electrical installations | * 1. Earthing types are identified   2. Earthing points on Electrical installation are identified   3. Calculation involved in determining the earthing type is performed   4. Test on an earthing system is performed in line with the IEE regulations |
| 1. Apply lightning protection measures | * 1. Types of lightning strikes are identified   2. Components of lightning protection system are identified   3. Test to be carried out in lightning protection system are established   4. Application of lightning protection system is determined |

**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**  May include but not limited to: |
| SI unit includes but not limited to: | * + Power – Watts (W)   + Current – Amperes (A)   + Resistance – Ohms(Ω)   + Voltage – Volts (V) |
| Quantities includes but not limited to: | * + Charge   + Current   + Resistance   + Voltage   + Power |

**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:

* Apply basic Electrical formulas
* Use of basic Electrical instruments
* Perform various unit conversions of Electrical quantities
* Electrical earthing
* Lightning arrestors
* Power factor correction
* Logical thinking
* Problem solving
* Applying statistics
* Drawing graphs
* Using different measuring tools

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Electrical power calculations
* Various laws in Electrical engineering
* Electrical formulas
* Power triangle
* SI units of various electrical parameters
* Earthing testing
* Lightening arrestor testing
* Selecting the correct type of electrical machines for various uses
* Types and purpose of measuring instruments
* Units of measurement and abbreviations

**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 the correct SI units of Electrical quantities   2. Stated, Calculate and relates the quantities in Ohm’s law   3. Identified the components of an earthing system   4. Stated and apply various laws in Electrical system   5. Differentiated between AC and DC network   6. Applied correct formulas in the calculation of AC and DC machines   7. Identified types of lightning arrestors and their applications |
| 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. Direct Observation   2. Demonstration with Oral Questioning   3. Written tests |
| 1. Context of Assessment | Competency may be assessed individually in the actual workplace or through accredited institution |
| 1. 5. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

# CORE UNITS OF COMPETENCY

## PERFORM BENCH WORK OPERATIONS

**UNIT CODE:** ENG/OS/MEM/CR/1/06/B

**UNIT DESCRIPTION**

The trainee will be able to use different methods to produce work pieces using basic hand tools while observing occupational safety and health legislations, regulations and safe working practices. In the context of the standards, the learner is to interpret and work within given specifications, select techniques and make variations to achieve specified results as well as perform housekeeping.

**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. Observe safety rules and regulations | 1.1 Prescribed personal safety gear is worn as per work place procedure.  1.2 Prescribed safety measures for the operation of hand tools and drilling machines adhered to as per rules and regulations  1.3 Prescribed safe work environment is observed as per rules and regulations  1.4 Prescribed workplace procedures are adhered to. |
| 2. Prepare operation plan | 2.1 Technical drawing sand geometric symbols are read and interpreted as per ***drawing standards.***  2.2 ***Operation Plan*** is produced as per the technical drawings |
| 3. Measure and mark out dimensions on work pieces | 3.1 Measuring and marking out tools suitable for the work are selected based on drawing specifications  3.2 Measuring tools are inspected and calibrated if required based on drawing specifications  3.3 Dimensions are marked on the work piece as per technical drawing standards |
| 4. Clamp work pieces on holding devices | 4.1 Work piece holding devices are identified as per job requirements  4.2 Work piece is clamped securely on ***work holding devices*** provided |
| 5. Use hand and power tools | 5.1 ***Hand and power tools*** are selected based on operation plan  5.2 Work piece is cut to ***specification*** |
| 6. Assemble parts and sub-assemblies | 6.1 Parts ***joined***, fitted and assembled as per working drawing  6.2 Final assembly inspected as per specification |
| 7. Perform finishing on components | 7.1 ***Finishing*** method selected as per the operation plan  7.2 Finished work is cleaned as per SOP  7.3 Work finished to specification |
| 8. Inspect finished work | 8.1 Inspection tools and methods selected as per operation plan  8.2 Finished work is inspected as per specification  8.3 Adjustments are made based on inspections results |
| 9. Maintain tools and equipment | 9.1 Tools and equipment are inspected as per job requirements  9.2 Tools are oiled and equipment lubricated  9.3 Faults on Tools and equipment are identified and reported |
| 10. Perform housekeeping activities | 10.1 Work environment cleaned  10.2 Waste sorted and disposed  10.3 Tools and equipment cleaned and stored as per workplace procedures and manufacturer’s manuals |

**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** |
| 1. Measuring tools may include but not limited to: | 1.1 Steel rule  1.2 Vernier caliper  1.3 Micrometer screw gauge  1.4 Vernier height gauge |
| 2. Drawing Standards may include but not limited to: | 2.1 ISO  2.2 BS  2.3 ANSI |
| 3. Operation Plan may include but not limited to: | 3.1 Sequence of operations  3.2 Measuring tools  3.3 Hand tools  3.4 Cutting tools  3.5 Inspection tools |
| 4. Marking out tools may include but not limited to: | 4.1 Scribers  4.2 Dividers  4.3 Dot punch  4.4 Centre punch |
| 5. Work holding devices may include but not limited to: | 5.1 Bench vice  5.2 V-Block  5.3 Angle plate  5.4 G-clamp  5.5 Jigs and fixtures  5.6 Hand vice |
| 6. Hand tools may include but not limited to: | 6.1 Files  6.2 Saws  6.3 Hammers  6.4 Chisels  6.5 Taps and dies |
| 7. Threads may include but not limited to: | 7.1 Internal and external threads  7.2 V-profile threads |
| 8. Finishing may include but not limited to: | 8.1 Emery cloth  8.2 Polishing and burnishing machine  8.3 Filing  8.4 Lapping  8.5 Painting |
| 9. Hole drilled may include but not limited to: | 9.1 Location  9.2 Counter sinking  9.3 Counter boring  9.4 Reaming  9.5 Boring |
| 10. Joining may include but not limited to: | 10.1 Riveting  10.2 Fastening  10.3 Soldering  10.4 Brazing  10.5Welding |

|  |  |
| --- | --- |
| **VARIABLE** | **RANGE** |
|  | 4.5 Engineers square  4.6 Straight edge  4.7 Surface plate |
| 5. Work holding devices may include but not limited to: | 5.1 Bench vice  5.2 V-Block  5.3 Angle plate  5.4 G-clamp  5.5 Jigs and fixtures  5.6 Hand vice |
| 6. Hand tools may include but not limited to: | 6.1 Files  6.2 Saws  6.3 Hammers  6.4 Chisels  6.5 Taps and dies |
| 7. Threads may include but not limited to: | 7.1 Internal and external threads  7.2 V-profile threads |
| 8. Finishing may include but not limited to: | 8.1 Emery cloth  8.2 Polishing and burnishing machine  8.3 Filing  8.4 Lapping  8.5 Painting |
| 9. Hole drilled may include but not limited to: | 9.1 Location  9.2 Counter sinking  9.3 Counter boring  9.4 Reaming  9.5 Boring |
| 10. Joining may include but not limited to: | 10.1 Riveting  10.2 Fastening  10.3 Soldering  10.4 Brazing  10.5Welding |
| 11. Specifications may include but not limited to: | 11.1 Dimensions  11.2 Tolerances  11.3 Geometry  11.4 Surface finish  11.5 Functionality |

**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:

* Technical drawing
* Using measuring and inspection tools
* Using hand tools
* Using portable and bench drilling machines
* Soldering and brazing
* Riveting and fastening

**Required Knowledge**

The individual needs to demonstrate knowledge and understanding of:

* Occupational Health and Safety Act of Kenya laws 2007 with focus on personal safety, machine safety and workplace
* National Environment Management Authority Act, Kenya 2004
* OSH act
* Equipment manuals
* Basic technical drawing complying to ISO, ANSI & BS standards
* ISO 1101 Geometrical tolerance and where to use the norm
* Work Planning and documentation
* Measuring tools
* Hand tools
* Bench work
* Portable and bench drilling machines
* Inspection and quality control
* Preventive maintenance of machine tools
* Metal cutting technology
* Materials and metallurgy
* WIBA act (2007)
* Report writing

**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 learner:  1.1 Observed safety rules and regulations in bench work operations  1.2 Prepared operation plan as per the technical drawing  1.3 Measured and marked out dimensions on the work piece as per the operation plan  1.4 clamped work pieces on holding devices as per the operation plan  1.5 Used hand and power tools as per the operation plan  1.6 Assembled parts and sub-assemblies as per the drawing specification  1.7 Performed finishing on components as per the drawing specification  1.7 Inspected finished work  1.8 Maintained tools and equipment  1.9 Performed housekeeping before, during and after operations |
| 2. Resource Implications | 1. Hand measuring tools 2. Hand marking tools 3. Hand tools 4. Inspection tools and equipment 5. Hand drilling machine 6. Bench Drilling machine 7. Work benches 8. Bench vices 9. ISO, BS and ANSI standards 10. Rules and procedures 11. Resource materials, manuals for bench, tools and equipment 12. Materials 13. Cutting tools |
| 3. Methods of  Assessment | Competency may be assessed through:  Observing the behavior of the learner  Oral presentations  Inspection of written operation procedures  Inspection of finished product  Observing housekeeping of the work area and/or machine tool |
| 4. Context of  Assessment | Competency may be assessed individually in the actual workplace or through accredited institution |
| 5. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## PERFORM MANUAL METAL ARC WELDING (MMAW)

**UNIT CODE:** ENG/OS/MEM/CR/02/6/B

**UNIT DESCRIPTION**

This unit describes occupational standards for manual metal Arc welding. The technician will be able to use different techniques in manual metal arc welding while observing safety rules and procedures. In the context of the standards, the technician is to interpret and work within given specifications, select techniques and make variations to achieve specified results as well as perform housekeeping.

**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. Observe safety rules and regulations | 1.1 Prescribed personal safety gear is worn as per work place procedure.  1.2 Prescribed safety measures for the operation of welding machines adhered to as per rules and regulations  1.3 Prescribed safe work environment is observed as per rules and regulations  1.4 Prescribed workplace procedures are adhered to |
| 2. Identify parts of Manual metal arc welding machine | * 1. Types of Manual metal arc welding machines identified   2.2 Parts and functions of Manual metal arc welding machine identified |
| 3. Demonstrate understanding of manual metal arc welding principle | 3.1 Arc generation principle is defined  3.2 Methods of striking an arc are demonstrated  3.3 **Parameters** determining the quality of the weld identified |
| 4.Identify weld joints and positions | 4.1 Welding joints identified as per the working drawing  4.2 ***Welding symbols identified as per the specification***  4.4 Welding positions identified as per the specification |
| 5 Prepare work piece | 5.1 ***Measuring***, ***marking*** and ***hand*** tools selected  5.2 Joint position measured and marked as per the work piece specifications  5.3 Joint area cleaned as per the SOP  5.4 Joint profile prepared based on joint type  5.5 Parts aligned and weld gap provided for |
| 6. Setup the Arc welding parameters | 6.1Electrode selected based on operation plan  6.2 AC/DC set according to the specification of the drawing, material and type of weld  6.3 Current set according to specifications of the drawing, material and type of weld  6.4 ***Polarity*** chosen based on specification of the drawing, material and type of weld |
| 7.Perform manual metal arc welding | 7.1 Work pieces are aligned and clamped  7.2 Parts are joined as per specified ***joint symbol*** and ***weld position***  7.3 Root run and other weld layers welded until  joint fills as per the specification |
| 8.Inspect the weld | 8.1 Visual inspection carried out  8.2 ***Destructive testing*** and inspection carried out  8.3 ***Non-destructive testing*** and inspection carried out |
| 9. Maintain the manual metal arc welding machine | 9.1 Machine, tools and equipment are inspected as per job requirements  9.2 Faults on machine, tools and equipment are identified and reported |
| 10. Perform housekeeping | 10.1 Work environment cleaned and maintained as per SOPs and workplace procedures  10.2Waste sorted and disposed  10.3 Machine, Tools and equipment cleaned and stored per workplace procedures and equipment manufacturer’s manuals |

**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** |
| 1. Technical drawing Standards include but is not limited to: | 1.1 ISO  1.2 BS  1.3 ANSI |
| 2. Geometry include but is not limited to: | 2.1 Form  2.2 Orientation  2.3 Location |
| 3. Operation Plan include but is not limited to: | 3.1 Sequence of operations  3.2 Measuring tools  3.3 Hand tools |
| 4. Marking out tools include but is not limited to: | 4.1 Scribers  4.2 Dividers  4.3 Engineers square  4.4 Straight edge |

|  |  |
| --- | --- |
| 5. Measuring tools include but is not limited to: | 5.1. Steel rule  5.2. Vernier caliper |
| 6. Hand tools include but is not limited to: | 6.1 Files  6.2 Saws  6.3 Hammers  6.4 Hand grinder  6.5 Wire brush  6.6 Clamps  6.7 Welding jigs and fixtures |
| 1. Parameters include but not limited to: | * 1. Amount of current   2. Arc length   3. Electrode angle   4. Joint geometry   5. Diameter of electrode   6. Condition of electrode(Dry) |
| 8. Electrodes include but is not limited to: | 7.1 Coated Mild Steel electrodes  7.2 Coated Low-Alloy Steel electrodes  7.3 Special metals electrodes |
| 8. Polarity include but is not limited to: | 8.1 Electrode-positive (reversed)  8.2 Electrode-negative (straight) |
| 9. Weld positions include but is not limited to: | * 1. Flat Position   2. Horizontal position   3. Vertical up-down and down-up   4. Overhead position   5. Inclined position |
| 10. Non-destructive testing include but is not limited to: | 10.1 Visual inspection  10.2 Radiographic   1. 3.Infrared Thermography    1. Ultrasonic    2. Magnetic particle    3. Dye penetrant |
| 11. Destructive testing include but is not limited to: | 11.1 Bend test  11.2 Tensile 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:

* Welding
* Measuring
* Technical drawing
* Material testing
* Weld inspection
* Weld positions
* Non-destructive testing (NDT)
* Destructive testing (DT)

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Occupational Health and Safety Act of Kenya laws 2007 with focus on personal safety, machine safety and workplace
* National Environment Management Authority Act, Kenya 2004
* OSH act
* Equipment manuals
* Technical drawing as per ISO, ANSI & BS standards
* Geometrical tolerance
* Work planning and documentation
* Measuring tools
* Hand tools
* Arc welding tools
* Weld defects and prevention measures
* Angle grander
* Inspection and quality control
* Materials and metallurgy
* WIBA act (2007)
* Report writing

**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 learner:  1.1 Observed safety rules and regulations in manual metal arc welding  1.2 Identified parts of manual metal arc welding machine  1.3 Demonstrated understanding of manual metal arc welding principle  1.4 Identified weld joints and positions  1.5 Prepared work piece  1.6 Set up the manual metal arc welding parameters  1.7 Performed manual metal arc welding  1.8 Inspected the weld  1.9 Maintained the manual metal arc welding machine  1.10 Performed housekeeping procedures |
| 2. Resource Implications | 2.1 Arc welding machine  2.2 Electrodes  2.3 Measuring tools  2.4 Marking tools  2.5 Hand tools  2.6 Inspection tools and equipment  2.7 Angle grinder  2.8 Work benches  2.9 Bench vices   * 1. Rules and procedures |
| 3.Methods of  Assessment | Competency may be assessed through:   * 1. Observation   2. Written assessment   3. Projects/ assignments   4. Practical |
| 4.Context of  Assessment | Competency may be assessed individually in the actual workplace or through accredited institution |
| 5. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## PERFORM OXY-ACETYLENE GAS WELDING AND CUTTING

**UNIT CODE:** ENG/OS/MEM/CR/03/6/B

**UNIT DESCRIPTION**

This unit specifies competencies required for preparation of materials, setting up of equipment and application of safety in oxy-acetylene gas welding and cutting. It also includes competencies in thermal joining and cutting of metals.

**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. Observe safety rules and regulations | * 1. Prescribed personal safety gear is worn as per work place procedure.   2. Prescribed safety measures for the operation of oxy-acetylene gas welding equipment are adhered to as per rules and regulations   3. Prescribed safe work environment is observed as per rules and regulations |
| 1. Identify parts of oxy-acetylene gas welding and cutting equipment | * 1. Parts of the oxy-acetylene gas welding and cutting equipment are identified   2. Functions of components Parts of oxy-acetylene gas welding and cutting equipment are identified |
| 1. Demonstrate understanding of oxy-acetylene gas welding and cutting principle | * 1. Lighting up and shut down procedure of oxy-acetylene gas equipment is demonstrated   2. The oxy-acetylene gas cutting procedure is demonstrated |
| 1. Identify weld joints and techniques | * 1. ***Welding joints*** identified as per the working drawing   2. ***Welding techniques*** identified as per the specification |
| 1. Prepare work piece | 5.1 Measuring, marking and hand tools selected as per job requirements  5.2 Work area cleaned as per the SOP  5.3 Parts aligned and weld gap provided for.  5.4 Work material cut to specifications |
| 1. Set up gas welding and cutting parameters | * 1. Pressure set according to SOP and job specifications   2. Gas ratio set according to SOP and job specifications |
| 1. Perform oxy-acetylene gas welding and cutting | * 1. Welding done to specification   2. Cutting done to specification |
| 1. Inspect the finished work | * 1. ***Destructive testing*** and inspection carried out   2. ***Non-destructive testing*** and inspection carried out   3. Kerf is examined as per standard operating procedures |
| 1. Maintain the oxy-acetylene gas welding and cutting equipment | * 1. Equipment and tools are inspected   2. Faults on equipment and tools are identified and reported |
| 1. Perform housekeeping | 10.1 Work environment cleaned SOPs and workplace procedures  10.2 Waste sorted and disposed  10.3 Equipment and tools are cleaned and stored per workplace procedures and equipment manufacturer’s manuals |

**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** |
| --- | --- |
| 1. Gas welding and cutting equipment include but not limited to: | * + Gas welding PPE   + Gas cylinders   + Gas welding torch   + Gas cutting torch   + Regulators   + Hoses   + Spark lighter/ gas lighter |
| 1. Materials include but not limited to: | * + Metal tubing   + Metal sheets   + Metal plates   + Metal bars |
| 1. Welding joints include but not limited to: | * + Lap joint   + Butt joint   + Fillet joint   + Corner joint |
| 1. Welding techniques include : | * + Leftward technique   + Rightward technique |
| 1. Non-destructive testing includes but is not limited to: | * + Dye penetrant   + Visual inspection   + Radiographic   + Infrared Thermography   + Ultrasonic   + Magnetic particle |
| 1. Destructive testing includes but is not limited to: | * + Tensile test   + Bend test |

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Workplace procedures and OSHA
* Gas welding equipment
* Joint preparation techniques
* Welding positions
* Gas welding techniques and specification procedure
* BS and ISO welded joint standards
* Workplace housekeeping procedures
* Gas cutting techniques
* Gas cutting equipment
* Gas cutting safety

**Required skills**

The individual needs to demonstrate the following skills:

* + Interpreting working drawings
  + Preparing joints
  + Gas welding
  + Gas cutting
  + Product assessment
  + Workplace housekeeping procedures

**EVIDENCE GUIDE**

This section 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. Observed safety rules and regulations as per Workplace procedures and OSHA   2. Identified parts of oxyacetylene gas welding and cutting equipment   3. Demonstrated understanding of oxy-acetylene gas welding and cutting principle   4. Identified weld joints and techniques used in oxy-acetylene gas welding as per the specification   5. Prepared work piece as per specification   6. Set up gas welding and cutting parameters as per job specifications   7. Performed gas welding as per job specifications and ISO 9006-1 standard   8. Performed gas cutting as per job specifications and ISO 9006-1 standard   9. Inspected the finished weld and kerf as per ISO 17637   10. Maintained the oxy-acetylene gas welding and cutting equipment as per the workplace procedures   11. Perform housekeeping |
| 1. Resource implications | The following resources must be provided:   * 1. Fully equipped gas welding workshop meeting OSHA standards   2. Gas welding and gas cutting consumables and equipment   3. Personal Protective Equipment |
| 1. Methods of assessment | Competency may be assessed through:   * 1. Observation   2. Oral questioning   3. Written tests   4. Projects |
| 1. Context of assessment | Candidate will be assessed individually in an actual workplace or in closely simulated work environment. |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## PERFORM LATHE OPERATIONS

**UNITCODE:** ENG/OS/MEM/CR/04/06/B

**UNIT DESCRIPTION:**

The trainee will be able to prepare a lathe machine tool and perform machining whilst adhering to rules and procedures. In the context of this standard, the learner is to interpret working drawing and work within given specifications to achieve specified results as well as perform housekeeping.

**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. Observe safety rules and regulations | 1.1 Prescribed personal safety gear is worn as per work place procedure.  1.2 Prescribed safety measures for the operation of a lathe machine are adhered to as per rules and regulations  1.3 Prescribed safe work environment is observed as per rules and regulations |
| 2. Identify lathe machine parts and their functions | 2.1 Types of lathe machines are identified  2.2 Parts and functions of a lathe machine are identified  2.3 ***Methods of specifying*** the lathe machine are identified |
| 3. Prepare operation plan | 3.1 Technical drawings and geometric symbols are read and interpreted as per ***drawing standards.***  3.2 ***Operation Plan*** is produced as per the technical drawings  3.3 Speed calculated as per the working drawing  3.4 Feed rate calculated as per working drawing |
| 4. Set up machine tool | 4.1 Cutting tools are selected as per the operation plan  4.2 Speed and feed selected as per the machine manual  4.3 ***Cutting tools and accessories*** set as per the SOP  4.4 Work piece is mounted on the chuck  4.5.True running of the work piece is observed |
| 5. Perform machining operation | 5.1 Work piece machined to specified dimensions as per drawing specifications  5.2 Work piece machined to specified surface finish  5.3 Dimensions of finished work piece checked as per drawing specifications |
| 6. Inspect finished work | 6.1 Inspection tools and methods selected as per operation plan  6.2. Finished work is inspected as per specification  6.3.Adjustments are made based on inspections results |
| 7. Maintain the lathe machine tool and accessories | 7.1 Lathe machine and accessories inspected as per SOP  7.2 Lathe machine cleaned, oiled and lubricated  7.3 Faults on lathe machine and accessories are identified and reported |
| 8. Perform housekeeping | 8.1 Working tools, measuring tools, equipment is cleaned and stored as per organization policy.  8.2 Waste is segregated and disposed as per disposal guidelines |

**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** |
| 1. Methods of specifying lathe machine includes but not limited to: | * Length of the bed * Swing over the carriage * Maximum diameter that can be held on the spindle |
| 1. Technical drawing standards includes but not limited to; | * ISO * BS * ANSI |
| 1. Cutting tools includes but not limited to; | * Knurling tools * Threading * Turning * Boring * Parting * Drilling bits |
| 1. Specifications includes but not limited to; | * Dimensions * Geometry * Surface finishing * Functionality |
| 1. Operation plan includes but not limited to; | * Sequence of operations * Measuring tool * Cutting tool including cutting data * Production time * Speed and feed rate * Cutting angles |

**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:

* Measuring and marking
* Technical drawing
* Material testing
* Drilling
* Boring
* Screw cutting

**Required knowledge**

The individual needs to demonstrate knowledge of***:***

* Occupational Health and Safety Act of Kenya laws 2007 with focus on personal safety, machine safety and workplace
* National Environment Management Authority Act, Kenya 2004
* Equipment manuals
* Technical drawing as per the ISO, ANSI & BS standards
* Geometrical tolerance
* Metal cutting processes using HM & HSS cutting tools
* Measuring tools
* Preventive maintenance
* Inspection and quality control
* Lathe operations
* WIBA act
* Report writing

**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 learner:  1.1 Observed safety rules and regulations as per work place procedures  1.2 Identified lathe machine parts and their functions  1.3 Prepared an operation plan as per the working drawing  1.4 Set up machine tools as per the operation plan  1.5 Performed machining operation as per the specification  1.6 Inspected the finished work as per the specification  1.7 Maintained the machine tool and accessories as per the workplace procedures  1.8 Performed housekeeping before, during and after operations |
| 2. Resource Implications | 2.1 Lathe  2.2 Cutting tools  2.3 Measuring tools  2.4 Blank Material  2.5 Resource materials, manuals for cutting tools & lathe  2.6 Work place procedures |
| 3. Methods of Assessment | Competency may be assessed through:  3.1 Observation  3.2 Practical  3.3 Written Assessment  3.4 Projects |
| 4. Context of Assessment | Competency may be assessed individually in the actual workplace or through accredited institution |
| 5. Guidance information for assessment | Holistic assessment of other units relevant to the industry sector, workplace and job role is recommended. |

## INSTALL MACHINE/EQUIPMENT

**UNIT CODE**: ENG/OS/MEM/CR/05/6/B

**Unit description**

This unit covers the competencies required to install mechanical machine/ equipment. It involves competencies to observe occupational health and safety, interpret installation manual, obtain work permit for authorization, prepare for installation, install machine/equipment, test and commission installation and perform housekeeping.

**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. Observe safety rules and regulations | * 1. Prescribed ***personal protective equipment (PPEs)*** is worn as per current OSHA rules and guidelines.   2. Prescribed safety measures for use of ***tools***, installation and operation of ***equipment/ machine*** are adhered to as per OSHA rules and regulations   3. Prescribed safe work environment is observed as per OSHA rules and regulations |
| 2. Interpret the installation manual | 2.1 Installation manual interpreted as per the manufacturer’s specifications and the ***drawing standards***.  2.2 Operation manual interpreted as per the manufacturer’s guidelines |
| 3.Obtain work permit for authorization | * 1. Copies of ***application documents*** are prepared and presented according to authorising authority requirements   2. Copies of application documents are certified according to authorisation requirements   3. Application is paid according to authorisation requirements   4. Copy of certified documents are presented to authority according to authorisation requirements   5. Permit is obtained according to work requirements |
| 1. Prepare for installation | * 1. Availability of ***System installation*** requirements are confirmed with supplier according to installation guidelines   2. Site is checked for correct location, dimension and levels etc. utilising appropriate measuring equipment.   3. Non-compliance with specification is reported to appropriate authority.   4. Alteration/correction is undertaken with approval of appropriate authority.   5. All surfaces, materials and components are prepared for use. |
| 1. Install machine/equipment | 1. Work safety is observed and adhered to according to OSHA rules and regulations 2. Relevant instructions/documentation for the installation is followed according to installation requirements 3. Installation tools and equipment are selected and checked to be in usable condition according to manual and legal requirement where applicable. 4. Installation manual is analysed according to work requirements 5. Installation, positioning and securing of ***machine*** is carried out using ***appropriate methods and techniques*** 6. Connections to the components are carried out to ensure that they are properly secured according to installation manual and Manufacturer’s SOPs 7. Installation is ***checked*** and any adjustments are done in accordance with the manufacturer’s specifications 8. Installation documentation is done according to Manufacturer’s SOPs |
| 1. Demonstrate understanding of testing and commissioning procedures | * 1. Relevant testing tools and equipment are identified according to system manuals   2. Machine/equipment is tested according to system functionality specifications   3. Calibration of parameters is done to achieve the desired results according to expected output and certified institutions where applicable.   4. Required raw materials are availed according to production requirement.   5. Operators are trained how to operate and maintain machines according to operation and maintenance manual   6. Commissioning of the machine is done as per the system manuals and commissioning procedures |
| 1. Perform housekeeping | * 1. Working tools, measuring tools, equipment is cleaned and stored as per organization policy and Manufacturer’s manuals.   2. Waste is segregated and disposed as per disposal guidelines |

**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** |
| --- | --- |
| Personal protective equipment may include but not limited to: | * Goggles * Ear muff * Safety mask * Helmets/head gear * Safety boots/shoes * Gloves * Overall/dust coat |
| Tools and equipment may include but not limited to: | * Hand tools * Power tools * Tool box * Material handling equipment |
| Drawing standards may include but not limited to: | * ISO * BS * ANSI |
| Application documents may include but not limited to: | * Academic certificates * Professional certificates * Identification documents * Legal documents |
| System installation requirements may include but not limited to: | * Power requirements * Pneumatic requirements * Housekeeping requirement e.g. waste clothes saw dust * Communication cables * Tools * Equipment |
| Machines may include but not limited to: | * Air compressors * Pumps * Blowers * Powered machine tools * Hydraulic machines * Pneumatic machines |
| Appropriate methods and techniques may include but not limited to: | * Marking out of locating and securing positions * Levelling equipment * Drilling and hole preparation * Shimming and packing * Fitting inserts (such as rag bolts or expanding bolts) * Fitting anti-vibration mountings * Positioning equipment * Securing by using mechanical fixings * Aligning equipment * Applying screw fastener locking devices * Make installation connections (such as mechanical, electrical, fluid power, utilities) |
| Checks may include but not limited to: | * Fill/replenish fluids, oil, or grease * Make visual checks for completeness and freedom from damage * Make `off-load' checks * Ensure that locking devices are fitted to fasteners (as appropriate) * Check level and/or alignment * Ensure that moving parts are clear of obstruction and/or guarded |

**REQUIRED KNOWLEDGE**

The individual needs to demonstrate knowledge of:

* Installation specification of the machine
* Procedures to follow if the location, dimensions and/or levels of the site do not comply with the specifications
* Procedures for checking whether the installed machine conforms to specifications
* Materials and components to be used in the installation of the machine
* Applicable codes and standards
* Installation sequence
* Methods to locate, fix/fasten machine/plant
* Methods of lifting/moving machine/plant and components
* Techniques, tools and equipment to measure site and machine/plant installation
* Use and application of personal protective equipment
* Safe work practices and procedures
* Hazards and control measures associated with installing machine/plant, including housekeeping
* Safety practices and procedures
* Fasteners
* Joining methods and techniques
* Quality control procedures
* Tools and equipment
* Material handling
* Problem solving
* Data analysis and interpretation
* Interpretation of technical drawings
* Documentation
* Testing and inspection
* Isolation and lock-off procedure
* Permit-to-work procedure
* Hazards associated with installing mechanical equipment
* Basic principle of operation of the equipment being installed
* Methods of marking out the site for positioning the equipment
* Techniques used to position, align, level and adjust the equipment
* Methods of lifting, handling and supporting equipment
* Procedure for safe disposal of waste materials
* Identification of installation defects (such as leaks, poor seals, misalignment, ineffective fasteners, foreign object damage, or contamination)

**REQUIRED SKILLS**

The individual needs to demonstrate skills in:

* Interpreting and following information on written job instructions, manufacturer specifications, standard operating procedures, charts, lists, reports and other applicable reference documents
* Interpreting layout drawings and specifications
* Checking and clarifying information
* Reporting – oral/written
* Planning and sequencing tasks
* Locating and verifying site and levels for installation
* Identifying non-compliances
* Preparing surfaces prior to commencing the installation
* Completing proformas, standard workplace forms, workplace reports and other applicable documents
* Checking for conformance to specifications
* Measuring to specified tolerances
* Performing numerical operations, geometry and engineering calculations/formulae within unit's scope
* Communication skills
* Problem solving
* Creativity and innovation
* Data collection and analysis
* Use of tools and equipment
* Technical presentation
* Technical drawing
* Installation and fabrication

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency. | * 1. Observed safety rules and regulations as per the workplace procedures and OSH Act.   2. Interpreted the installation manuals as per the manufacturer’s specification   3. Obtained work permit for authorization according to work and authorising authority requirements   4. Prepared for installation as per the installation guidelines   5. Installed machine/equipment according to installation manual and SOPs   6. Demonstrated testing and commissioning procedures of machine/equipment according to systems manual and requirements   7. Performed housekeeping as per the workplace requirements |
| 1. Resource Implications. | * 1. Lifting equipment   2. Measuring tools   3. Hand tools   4. Lubricants   5. Draw bolts   6. Inspections tools |
| 1. Methods of Assessment. | ***Competency may be assessed through:***   * 1. Practical   2. Observation   3. Questionnaire   4. Case studies   5. Written examinations   6. Oral presentation |
| 1. Context of Assessment. | Competency may be assessed individually in an actual workplace or in work-simulated conditions within accredited institutions. |
| 1. Guidance information for assessment. | This unit may be assessed on an integrated basis with others within this occupational sector. |

## PERFORM MACHINE/ EQUIPMENT MAINTENANCE

**UNIT CODE:** ENG/OS/MEM/CR/06/6/B

**Unit description**

This unit describes the competencies required by a technician to perform machine /equipment maintenance. It involves competencies required to inspect equipment/machine, identify machine/equipment needs, plan and prepare for maintenance, conduct breakdown maintenance, conduct preventive maintenance, test, document maintenance work done where applicable on machine/equipment and perform housekeeping.

**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. Inspect machine/equipment | * 1. Work safety is observed and adhered to according to the current OSHA rules and guidelines.   2. Inspection checklist is developed according to machine/equipment manufacturer’s manuals and maintenance procedures   3. Correct specification for the machine/equipment being inspected is followed according to manufacturer’s manual   4. Correct equipment to carry out the inspection is used according to inspection manual   5. Inspection checks to be made and acceptance criteria to be used is identified and confirmed according to machine/equipment requirements   6. All required inspections as specified are carried out according to machine/equipment requirements   7. Any defects or variations from the specification are identified and rectified if possible, according to machine/equipment requirements   8. Results of the inspection are recorded according to SOPs |
| 1. Identify machine /equipment maintenance needs | * 1. Work safety is observed and adhered to according to the current OSHA rules and guidelines.   2. ***Maintenance types*** are defined according to inspection results.   3. Maintenance manuals are analysed according to work requirements   4. ***Components***to be maintained are identified according to system requirement |
| 1. Prepare for machine/equipment maintenance | * 1. Health and safety precautions are observed according to the current OSHA rules and guidelines.   3.2 Maintenance records are checked and analyzed according to work requirements   * 1. Work plan is developed according to work requirements.   2. Clear priority rules are set according to work requirements   3. ***Tools and equipment*** are identified and checked to be in usable conditions according to manufacturers’ manual.   4. Consumables, spare parts and materials availability is checked according to work requirements.   5. Availability of required labour is checked according to work requirement. |
| 1. Conduct preventive maintenance | * 1. Work safety is observed and adhered to according to health and safety legislation and regulations   2. All people affected by required preventive maintenance and their impact are notified according to organisational procedures   3. Machine/Equipment is checked to be correctly set up for preventive maintenance according to maintenance manual   4. Relevant data from technical or supporting manuals is accessed to assist with preventive maintenance according to organisation’s regulations   5. Lubrication status of moving parts of the machine is done according to maintenance procedures   6. Cleaning of components is carried out according to maintenance procedures   7. Preventive maintenance of all components is performed according to maintenance schedule/protocol   8. Instances where the maintenance activities cannot be fully met or where there are identified defects outside the planned schedule are reported according to organisation’s regulations   9. Components are repainted according to maintenance manual   10. Relevant maintenance records are completed according to SOPs   11. Machine is handed over according to existing organizational policy |
| 1. Conduct corrective maintenance | * 1. Work safety is observed and adhered to according to health and safety legislation and regulations   2. Machine is switched off from power supply according to user manual.   3. Appropriate signage is placed on both control and operation panel according to organization procedures.   4. Machine is inspected according to work requirements   5. Identified faulty assemblies are dismantled and marked for repair according to maintenance manual, parts are lubricated according to manufacturer’s recommendation   6. Maintained machine/equipment is tested according to manufacturer’s manual   7. Maintenance records are updated according to SOPs   8. Machine/Equipment is handed over according to existing organizational policy. |
| 1. Test machine /equipment for functionality | * 1. Health and safety precautions are observed according to OSHA   2. Relevant testing tools and equipment are identified according to system manuals   3. Machine/equipment is tested and rectified where applicable according to system functionality specifications   4. Calibration of parameters is done to achieve the desired results according to expected output   5. Maintenance records are updated according to SOPs   6. Machine/Equipment is handed over according to existing organizational policy |
| 1. Perform housekeeping | 7.1 Working tools, measuring tools, equipment is cleaned and stored as per organization policy.  7.2 Waste is segregated and disposed as per disposal guidelines |

**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** |
| --- | --- |
| * Tools and equipment may include but not limited to: | * Hand tools * Inspection tools * Measuring tools * Power tools * Machine tools |
| * Maintenance types may include but not limited to: | * Preventive maintenance * Corrective maintenance |
| * Components may include but not limited to: | * Bearings * Couplings and linkages * Conveyers * Gears * Shafts * Belts and pulleys * Chain and sprocket |

**REQUIRED KNOWLEDGE**

The individual needs to demonstrate knowledge of:

* Technical report writing
* PPE
* Site and equipment safety requirements
* Equipment and machine characteristics, technical capabilities and limitations
* Equipment and machine operational procedures
* Site equipment and machine maintenance procedures
* Site environmental requirements and constraints related to operational maintenance activities
* Interpretation of technical drawings
* Inspection methods and techniques
* Calibration of equipment
* Defects identification
* Types of tools and equipment
* Electrical and mechanical machine drives
* Machine operation
* Types of maintenance
* Manual interpretation
* Scheduling/planning for maintenance
* Performance parameters, principles of operation, capabilities and limitations of specified equipment
* Factors affecting decisions on maintenance activity
* Risks associated with unsafe or non-maintained equipment
* Waste disposal procedures
* Type and range of records required for maintenance of equipment
* Fault and error message diagnosis and appropriate actions
* Dissemination of maintenance plans
* Generation equipment and machine, its location and operating parameters
* Legislation, industry standards, codes of practice and regulations
* Maintenance methods
* Maintenance plan development using maintenance planning philosophies and practices
* Maintenance plan implementation
* Manufacturers' specifications and manuals
* Quality control
* Risk management
* OHS legislated requirements including:
* Emergency procedures
* Risk control measures
* Safe working practices
* Workplace documentation
* Workplace policies and procedures

**REQUIRED SKILLS**

The individual needs to demonstrate skills in:

* Communication skills
* Problem solving
* Data collection and analysis
* Use of tools and equipment
* Technical drawing
* Service and repair of system components
* Fault diagnosis
* Basics on mechanical maintenance
* Use of test and measuring instruments
* Planning
* Organisation

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency. | * 1. Inspected equipment / machine according to inspection manual and OSH act   2. Identified equipment / machine maintenance needs according to maintenance manual and work requirements   3. Planned and prepared for equipment / machine maintenance according to manufacturer’s manual   4. Conducted corrective maintenance according to manufacturer’s recommendation   5. Conducted preventive maintenance according to manufacturer’s recommendation and workplace requirements   6. Tested equipment / machine for function ability according to the systems manual where applicable   7. Documented the maintenance process as per the SOPs   8. Performed housekeeping as per the workplace requirements |
| 1. Resource Implications. | * 1. Computers   2. Software   3. Tools and equipment   4. Manuals   5. Testing tools   6. Raw materials (spares, lubricants, oils, test-pieces) |
| 1. Methods of Assessment. | Competency may be assessed through***:***   * 1. Practical   2. Observation   3. Questionnaire   4. Case studies   5. Written examinations   6. Oral presentation |
| 1. Context of Assessment. | Competency may be assessed individually in an actual workplace or in work-simulated conditions within accredited institutions. |
| 1. Guidance information for assessment. | This unit may be assessed on an integrated basis with others within this occupational sector. |

## MAINTAIN HYDRAULIC AND PNEUMATIC SYSTEMS

**UNIT CODE:** ENG/OS/MEM/CR/07/06/B

**UNIT DESCRIPTION**

This unit covers the competencies required to maintain hydraulic and pneumatic systems. Competencies include; to identify, inspect systems to be maintained, prepare maintenance components, performing testing of the maintained system, documenting system maintenance report and perform housekeeping.

**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 system to be maintained | * 1. Work safety is observed and adhered to according to the current OSHA rules and guidelines.   2. Hydraulic/ pneumatic system is identified in line with the manual specifications   3. Hydraulic/ pneumatic ***system*** is identified based on their functionality   4. Identification of the Hydraulic/ pneumatic system is performed as per prevailing working environment   5. Hydraulic/ pneumatic system is identified in line with their respective circuits |
| 1. Inspect system to be maintained | * 1. Work safety is observed and adhered to according to the current OSHA rules and guidelines.   2. Inspection checklist is developed according to system specifications   3. Correct specification for the system being inspected is followed according to manufacturer’s manual   4. Correct equipment to carry out the inspection is used according to inspection manual   5. Inspection checks to be made and acceptance criteria to be used is identified and confirmed according to Hydraulic/ pneumatic system requirements   6. All required inspections as specified are carried out according to system requirements   7. Any defects or variations from the specification are identified according to system requirements   8. Results of the inspection are recorded according to SOPs |
| 1. Prepare components and materials for maintenance | * 1. Health and safety precautions are observed according to the current OSHA rules and guidelines.   2. Maintenance records are checked and analysed according to work requirements   3. Work plan is developed according to work requirements.   4. Clear priority rules are set according to work requirements   5. Tools and equipment are identified and checked to be in usable conditions according to manufacturers’ manual.   6. Consumables, spare parts and materials availability are checked according to work requirements. |
| 1. Perform system maintenance | * 1. Work safety is observed and adhered to according to the current OSHA rules and guidelines.   2. Hydraulic/ pneumatic system is switched off from power supply according to user manual.   3. Appropriate signage is placed on both control and operation panel according to organization procedures.   4. Hydraulic/ pneumatic system is inspected according to work requirements   5. Identified faulty assemblies are dismantled and marked for identification according to maintenance manual, parts are lubricated according to manufacturer’s recommendation   6. Hydraulic/ pneumatic system is handed over to according to existing organizational policy |
| 1. Test the maintained system | * 1. Health and safety precautions are observed according to the current OSHA rules and guidelines.   2. Relevant testing tools and equipment are identified according to system manuals   3. Hydraulic and pneumatic system is tested and rectified where applicable according to system functionality specifications   4. Calibration of parameters is done to achieve the desired results according to expected output |
| 1. Perform housekeeping tasks | 6.1 Working tools, measuring tools, equipment are cleaned and stored as per organization policy.  6.2 Waste is segregated and disposed as per disposal guidelines |

**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** |
| --- | --- |
| System includes but not limited to: | * Pneumatic systems * Hydraulic systems |

**REQUIRED KNOWLEDGE AND UNDERSTANDING**

The individual needs to demonstrate knowledge and understanding of:

* Fluid mechanics
* Material science
* Thermodynamic systems
* Different hydraulic systems
* Compressors
* Plant machines
* Basic instruments
* Tools and equipment
* Different types of pneumatic systems
* Basic plumbing
* Interpretation of various machines manufacturers manuals
* Different workshop tools and material
* Management of different wastes
* Maintenance of work area
* Record keeping procedure
* Data analysis and presentation
* Project management
* Analysis and design methods

**REQUIRED SKILLS**

| The individual needs to demonstrate the following required skills: |
| --- |
| * Operating different hydraulic systems * PPE at work stations * Waste segregation and management * Maintaining work area * Practicing 5s of good housekeeping and 3Rs * Safety at work stations * Information record keeping * Troubleshooting and maintenance of hydraulic and pneumatic systems * Management * Leadership * Coordination * Problem solving; * Decision making; * Planning; * Report writing; |

**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. Adhered to safety rules and regulations in components handling during their preparation and maintenance   2. Identified system to be maintained as per the client’s requirements   3. Inspected the system to be maintained in line with their specifications   4. Prepared for maintenance components and materials as per work requirements and systems manual   5. Performed system maintenance according to the system manual and workplace requirements   6. Performed testing of the maintained system as per the system specification   7. Documented system maintenance report as per the organization approved format   8. Performed housekeeping as per the organization requirement |
| 1. Resource Implications | Resources the same as that of workplace are advised to be applied.  Including but not limited to:   1. Hydraulic pumps, 2. pneumatic systems, 3. stationeries, 4. computers, 5. valves, 6. lubricants, 7. pipes, 8. fittings. |
| 1. Methods of Assessment | This competency may be assessed through:   * 1. Observation   2. Practical demonstrations   3. Oral Questioning   4. Written tests |
| 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. |

## MAINTAIN PUMPS AND AIR COMPRESSORS

**UNIT CODE:** ENG/OS/MEM/CR/08/6/B

**UNIT DESCRIPTION**

This unit covers the competencies required to maintain pumps and air compressors. Competencies include; identify components to be maintained, inspect components, prepare for maintenance, perform maintenance and testing, document maintenance process and perform housekeeping.

**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 components to be maintained. | * 1. ***Component*** to be maintained is identified as per the client’s requirements   2. Component is identified in line with its specification   3. Component is identified based on its functionality   4. Identification of the component is performed as per prevailing working environment   5. Component is identified in line with its complexity |
| 1. Inspect component to be maintained | * 1. Work safety is observed and adhered to according to the current OSHA rules and guidelines.   2. Inspection checklist is developed according to component ***system*** specifications   3. Correct specification for the component being inspected is followed according to ***manufacturer’s*** manual   4. Correct equipment to carry out the inspection is used according to inspection manual   5. Inspection checks to be made and acceptance criteria to be used is identified and confirmed according to component requirements   6. All required inspections as specified, are carried out according to component requirements   7. Any defects or variations from the specification are identified and rectified if possible, according to component requirements with the engineering best practice   8. Results of the inspection are recorded according to SOPs |
| 1. Prepare components and materials for maintenance | * 1. Health and safety precautions are observed according to the current OSHA rules and guidelines.   2. Maintenance records are checked and analysed according to work requirements   3. Work plan is developed according to work requirements.   4. Clear priority rules are set according to work requirements   5. Tools and equipment are identified and checked to be in usable conditions according to manufacturer’s manual.   6. Consumables, spare parts and materials availability are checked according to work requirements. |
| 1. Perform component maintenance | * 1. Work safety is observed and adhered to according to the current OSHA rules and guidelines.   2. System is switched off from power supply according to user manual.   3. Appropriate signage is placed on both control and operation panel according to organization procedures.   4. System is inspected according to work requirements   5. Identified faulty assemblies are dismantled and marked for identification according to maintenance manual, parts are lubricated according to manufacturer’s recommendation   6. System is handed over to according to existing organizational policy |
| 1. Test run the maintained pump/air compressor | * 1. Pump/compressor testing is performed in line with the expected alignment deviation   2. Testing is performed according to the ***manufacturer’s manuals***   3. Testing is conducted in line with pump’s/ air compressor’s expected output   4. Testing is performed according to the expected vibration limits   5. Temperature test is performed within the expected limits   6. Noise test is conducted in line with the pump’s/air compressor’s designed limits   7. Testing is performed according to engineering best practice   8. Pump/air compressor maintenance report is filed and documented based on the organizations filing system and policies |
| 1. Perform housekeeping tasks | 6.1 Working tools, measuring tools, equipment is cleaned and stored as per organization policy.  6.2 Waste is segregated and disposed as per disposal guidelines |

**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** |
| --- | --- |
| Manufacturers includes but not limited to: | * Kirloskar * Davis and Shirtliff |
| Components includes but not limited to: | * Seals * Pistons * Valves * Vanes * Hoses * Pressure gauges * Storage cylinders |
| Systems includes but not limited to: | * Centrifugal pumps * Reciprocating pumps * Compressed air distribution system * Air compressors |

**REQUIRED KNOWLEDGE AND UNDERSTANDING**

***The individual needs to demonstrate knowledge and understanding of:***

|  |
| --- |
| * Fluid mechanics * Material science * Fabrication * Thermodynamics * Basic knowledge on plumbing * Different types of pumps and their functionality and application * Principles of operation of air compressors * Drawing * Report preparation and filing * Workshop tools and material * Standard procedures in pump installation * Standard procedures in air compressor maintenance installation * Environmental conditions * Management of different wastes * Workmanship * Record keeping procedure * Maintenance * Data analysis and presentation * Digital Literacy * Project management * Tendering and procurement * Analysis and design methods * Automation |

**REQUIRED SKILLS**

|  |
| --- |
| The individual needs to demonstrate the following skills: |
| * Preparing assessment report * Selection of maintenance tools and equipment * Reading and interpretation of manufacturer’s manuals on work and maintenance * Lubricants * PPE at different work stations * Practicing safety practices * Troubleshooting * Waste segregation and management   **ATTITUDES**   * Leadership * Coordination * Planning * Analysis |

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   * 1. Observed and adhered to work safety according to health and safety legislation and regulations   2. Identified components to be maintained as per the client’s requirements   3. Inspected components to be maintained as per the systems specification   4. Prepared components and materials for maintenance as per work requirements and components systems manual   5. Performed component maintenance according to the component system manual and workplace requirements   6. Test run the maintained pump, air compressor and compressed air distribution system as per the manufacturers specification   7. Documented components maintenance report as per the organization approved format   8. Performed housekeeping as per the organization requirement |
| 1. Resource Implications | Resources the same as that of workplace are advised to be applied including   * 1. Workshops   2. Toolboxes   3. PPEs   4. Spares   5. Materials (oils, air, lubricants) |
| 1. Methods of Assessment | Competency may be assessed through:   * 1. Observation   2. Oral questioning   3. Practical tests   4. Written tests |
| 1. Context of Assessment | Competency may be assessed individually   * 1. In the actual workplace   2. Simulated environment of the work place |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |