****

**REPUBLIC OF KENYA**

**COMPETENCY BASED CURRICULUM**

**FOR**

**WELDING AND FABRICATION**

**LEVEL 6**



TVET CDACC

P.O. BOX 15745-00100

NAIROBI

First published 2018

© 2018, TVET CDACC

All rights reserved. No part of this Curriculum may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods without the prior written permission of the TVET CDACC, except in the case of brief quotations embodied in critical reviews and certain other non-commercial uses permitted by copyright law. For permission requests, write to the Council Secretary/CEO, at the address below:

**Council Secretary/CEO**

**TVET Curriculum Development, Assessment and Certification Council**

**P.O. Box 15745–00100**

**Nairobi, Kenya**

**Email:** **info@tvetcdacc.go.ke**

# FOREWORD

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

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

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

**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 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 a shift to CBET to address the mismatch between skills acquired through training and skills needed by industry as well as increase the global competitiveness of Kenyan labour force.

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

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

 I am grateful to the Council members, Council Secretariat, Mechanical Engineering Sector Skills Advisory Committee (SSAC), expert workers and all those who participated in the development of this Curriculum.

**CHAIRPERSON, TVET CDACC**

# ACKNOWLEDGEMENT

This Curriculum has been designed for competency-based training and has independent units of learning that allow the trainee flexibility in entry and exit. In developing the Curriculum, significant involvement and support was received from various organisations.

I recognize with appreciation the role of the Mechanical Engineering SSAC in ensuring that competencies required by the industry are addressed in the Curriculum. I also thank all stakeholders in the Welding and Fabrication sector for their valuable input and all those who participated in the process of developing this Curriculum.

I am convinced that this Curriculum will go a long way in ensuring that workers in Welding and Fabrication sector acquire competencies that will enable them to perform their work more efficiently.

**COUNCIL SECRETARY/CEO**

**TVET CDACC**

Table of Contents

[FOREWORD iii](#_Toc69470700)

[PREFACE iv](#_Toc69470701)

[ACKNOWLEDGEMENT v](#_Toc69470702)

[ABBREVIATIONS AND ACRONYMS viii](#_Toc69470703)

[KEY TO UNIT CODE ix](#_Toc69470704)

[COURSE OVERVIEW 1](#_Toc69470705)

[BASIC UNITS OF LEARNING 4](#_Toc69470706)

[COMMUNICATION SKILLS 5](#_Toc69470707)

[DIGITAL LITERACY 9](#_Toc69470708)

[ENTREPRENEURIAL SKILLS 12](#_Toc69470709)

[EMPLOYABILITY SKILLS 16](#_Toc69470710)

[ENVIRONMENTAL LITERACY 22](#_Toc69470711)

[OCCUPATIONAL SAFETY AND HEALTH PRACTICES 26](#_Toc69470712)

[COMMON UNITS OF LEARNING 29](#_Toc69470713)

[TECHNICAL DRAWING 30](#_Toc69470714)

[ENGINEERING MATHEMATICS 33](#_Toc69470715)

[MECHANICAL SCIENCE PRINCIPLES 39](#_Toc69470716)

[FLUID MECHANICS PRINCIPLES 42](#_Toc69470717)

[THERMODYNAMICS PRINCIPLES 44](#_Toc69470718)

[MATERIAL SCIENCE AND PERFORM METALLURGICAL PROCESSES 48](#_Toc69470719)

[CORE UNITS OF LEARNING 52](#_Toc69470720)

[SOLDERING AND GAS WELDING 53](#_Toc69470721)

[MANUAL METAL ARC WELDING 57](#_Toc69470722)

[TUNGSTEN INERT GAS (TIG) WELDING 60](#_Toc69470723)

[METAL ACTIVE GAS (MAG) WELDING 62](#_Toc69470724)

[SPOT AND SEAM RESISTANCE WELDING 64](#_Toc69470725)

[UNDERWATER ARC WELDING 67](#_Toc69470726)

[SUBMERGED ARC WELDING 69](#_Toc69470727)

[PLASMA AND LASER BEAM WELDING 72](#_Toc69470728)

[WELDING INSPECTION AND QUALITY CONTROL 75](#_Toc69470729)

[DESIGN OF PRODUCTS AND STRUCTURES 77](#_Toc69470730)

[FABRICATION OF PRODUCTS AND STRUCTURES 79](#_Toc69470731)

# ABBREVIATIONS AND ACRONYMS

BC Basic competency

CBET Competency Based Education and Training

CC Common competency

CR Core competency

CU Curriculum

ENG Engineering

KCSE Kenya Certificate of Secondary Education

KNQA Kenya National Qualifications Authority

OSH Occupational Safety and Health

PPE Personal Protective Equipment

SSAC Sector Skills Advisory Committee

 CDACC Curriculum Development, Assessment and Certification Council

TVET Technical and Vocational Education and Training

WEF Welding and Fabrication

# KEY TO UNIT CODE

 ENG /CU /WEF/BC /01/ 6/ A

Industry or sector

Curriculum

Occupational area

Type of competency

Competency number

Competency level

Version control

# COURSE OVERVIEW

Welding and Fabrication Level 6 qualification consists of competencies that a person must achieve to enable him/her to carry out various welding processes including gas welding, manual metal arc welding, Tungsten Inert Gas (TIG) welding and Metal Active Gas (MAG) welding. In addition, it also involves competencies for performing welding quality control, designing products and structures and fabricating products and structures.

This course consists of the following basic, common and core units of learning:

**Basic Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Duration in Hours** | **Credit Factors** |
| ENG/CU/WEF/BC/01/6/A | Communication skills  | 40 | 4 |
| ENG/CU/WEF/BC/02/6/A | Digital literacy | 60 | 6 |
| ENG/CU/WEF/BC/03/6/A | Entrepreneurial skills | 100 | 10 |
| ENG/CU/WEF/BC/04/6/A | Employability skills | 80 | 8 |
| ENG/CU/WEF/BC/05/6/A | Environmental literacy | 40 | 4 |
| ENG/CU/WEF/BC/06/6/A | Occupational safety and health practices | 40 | 4 |
| **Total** | **360** | **36** |

**Common Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Duration in Hours** | **Credit Factors** |
| ENG/CU/WEF/CC/01/6/A | Technical drawing | 150 | 15 |
| ENG/CU/WEF/CC/02/6/A | Engineering Mathematics | 150 | 15 |
| ENG/CU/WEF/CC/03/6/A | Mechanical science principles | 75 | 7.5 |
| ENG/CU/WEF/CC/04/6/A | Fluid mechanics principles  | 75 | 7.5 |
| ENG/CU/WEF/CC/05/6/A | Thermodynamics principles  | 75 | 7.5 |
| ENG/CU/WEF/CC/06/6/A | Material science and perform metallurgical processes | 75 | 7.5 |
| **Total** | **600** | **60** |

**Core Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit Code** | **Unit Title** | **Duration in Hours** | **Credit Factors** |
| ENG/CU/WEF/CR/01/6/A | Soldering and gas welding | 180 | 18 |
| ENG/CU/WEF/CR/02/6/A | Manual metal arc welding | 360 | 36 |
| ENG/CU/WEF/CR/03/6/A | Tungsten Inert Gas (TIG) welding | 180 | 18 |
| ENG/CU/WEF/CR/04/6/A | Metal Active Gas (MAG) welding | 180 | 18 |
| ENG/CU/WEF/CR/05/6/A | Spot and seam resistance welding | 90 | 9 |
| ENG/CU/WEF/CR/06/6/A | Underwater arc welding | 90 | 9 |
| ENG/CU/WEF/CR/07/6/A | Submerged arc welding | 90 | 9 |
| ENG/CU/WEF/CR/08/6/A | Plasma and laser beam welding | 90 | 9 |
| ENG/CU/WEF/CR/09/6/A | Welding inspection and quality control | 60 | 6 |
| ENG/CU/WEF/CR/10/6/A | products and structures Designing  | 90 | 9 |
| ENG/CU/WEF/CR/11/6/A | Fabrication of products and structures  | 180 | 18 |
|  | Industrial attachment  | 480 | 48 |
| **Total** | **2070** | **207** |
| **Grand total** |  **3030** | **303** |

The total duration of the course is 3030 hours including 480 hours of industrial attachment.

The units of learning spot and seam resistance welding, underwater arc welding, submerged arc welding and plasma and laser beam welding are optional.

**Entry Requirements**

A trainee entering this course should have any of the following minimum requirements:

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

**Or**

1. Welding and Fabrication Level 5 Certificate

**Or**

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

**Trainer qualification**

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

**Industrial Attachment**

An individual enrolled in this course will undergo four hundred and eighty (480) hours industrial attachment in a welding and fabrication firm.

An individual enrolled in one of the core units of learning will undergo a forty (40) hours attachment.

**Assessment**

The course will be assessed at two levels: internal and external.

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

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

**Certification**

An individual will be awarded a Certificate of Competency on demonstration of competence in a unit of competency. To be awarded a National Certificate in Welding and Fabrication Level 6, an individual must demonstrate competence in all the units of competency.

These certificates will be awarded by TVET CDACC in conjunction with the training provider.

# BASIC UNITS OF LEARNING

## COMMUNICATION SKILLS

**UNIT CODE:** ENG/CU/WEF/CC/01/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Communication Skills

**Duration of Unit:** 40 hours

**Unit Description**

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

**Summary of Learning Outcomes**

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

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

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

**Suggested Methods of Instruction**

* Discussion
* Role playing
* Simulation
* Direct instruction

**Recommended Resources**

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

## DIGITAL LITERACY

**UNIT CODE:** ENG/CU/WEF/CC/02/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Digital Literacy

**Duration of Unit:** 60 hours

**Unit Description**

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

**Summary of Learning Outcomes**

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

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

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

**Suggested Methods of Instruction**

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

**Recommended Resources**

* Computers
* Printers
* Storage devices
* Internet access

## ENTREPRENEURIAL SKILLS

**UNIT CODE:** ENG/CU/WEF/CC/03/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Entrepreneurial Skills

**Duration of unit:** 100 hours

**Unit Description**

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

**Summary of Learning Outcomes**

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Demonstrate knowledge of entrepreneurship and self-employment
 | * Importance of self-employment
* Requirements for entry into self-employment
* Role of an Entrepreneur in business
* Contributions of Entrepreneurs to National development
* Entrepreneurship culture in Kenya
* Born or made entrepreneurs
 | * Individual/group assignments
* Projects
* Written tests
* Oral questions
* Third party report
 |
| 1. Identify entrepreneurship opportunities
 | * Business ideas and opportunities
* Sources of business ideas
* Business life cycle
* Legal aspects of business
* Assessment of product demand
* Business environment
* Factors to consider when evaluating business environment
* Technology in business
 | * Individual/group assignments
* Projects
* Written tests
* Oral questions
* Third party report
* Interviews
 |
| 1. Create entrepreneurial awareness
 | * Forms of businesses
* Sources of business finance
* Factors in selecting source of business finance
* Governing policies on Small Scale Enterprises (SSEs)
* Problems of starting and operating SSEs
 | * Individual/group assignments
* Projects
* Written tests
* Oral questions
* Third party report
* Interviews
 |
| 1. Apply entrepreneurial motivation
 | * Internal and external motivation
* Motivational theories
* Self-assessment
* Entrepreneurial orientation
* Effective communications in entrepreneurship
* Principles of communication
* Entrepreneurial motivation
 | * Case studies
* Individual/group assignments
* Projects
* Written tests
* Oral questions
* Third party report
* Interviews
 |
| 1. Develop business innovative strategies
 | * Innovation in business
* Small business Strategic Plan
* Creativity in business development
* Linkages with other entrepreneurs
* ICT in business growth and development
 | * Case studies
* Individual/group assignments
* Projects
* Written tests
* Oral questions
* Third party report
* Interviews
 |
| 6. Develop Business Plan | * Business description
* Marketing plan
* Organizational/Management
* plan
* Production/operation plan
* Financial plan
* Executive summary
* Presentation of Business Plan
 | * Case studies
* Individual/group assignments
* Projects
* Written tests
* Oral questions
* Third party report
* Interviews
 |

**Suggested Methods of Instruction**

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

**Recommended Resources**

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

## EMPLOYABILITY SKILLS

**UNIT CODE:** ENG/CU/WEF/CC/04/6/A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Demonstrate Employability Skills

**Duration of Unit:** 80 hours

**Unit Description**

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

**Summary of Learning Outcomes**

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

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

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

**Suggested Methods of Instruction**

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

**Recommended Resources**

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

## ENVIRONMENTAL LITERACY

**UNIT CODE**:ENG/CU/WEF/CC/05/6/A

**Relationship to Occupational Standards**:

This unit addresses the Unit of Competency : Demonstrate Environmental Literacy

**Duration of Unit:** 40 hours

**Unit Description**

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

**Summary of Learning Outcomes**

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

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

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

**Suggested Methods of Instruction**

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

**Recommended Resources**

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

## OCCUPATIONAL SAFETY AND HEALTH PRACTICES

**UNIT CODE:** ENG/CU/WEF/CC/06/6/A

**Relationship to Occupational Standards**

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

**Duration of Unit:** 40 hours

**Unit Description**

This unit specifies the competencies required to demonstrate occupational health and safety practices. It involves identifying workplace hazards and risk, identifying and implementing appropriate control measures to hazards and risks and implementing OSH programs, procedures and policies/guidelines.

**Summary of Learning Outcomes**

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

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify workplace hazards and risks
 | * Identification of hazards in the workplace and/or the indicators of their presence
* Evaluation and/or work environment measurements of OSH hazards/risk existing in the workplace
* Gathering of OSH issues and/or concerns
 | * Oral questions
* Written tests
* Portfolio of evidence
* Third party report
 |
| 1. Control OSH hazards
 | * Prevention and control measures e.g. use of PPE
* Risk assessment
* Contingency measures
 | * Oral questions
* Written tests
* Portfolio of evidence
* Third party report
 |
| 1. Implement OSH

 programs | * Company OSH program, evaluation and review
* Implementation of OSH programs
* Training of team members and advice on OSH standards and procedures
* Implementation of procedures for maintaining OSH-related records
 | * Oral questions
* Written tests
* Portfolio of evidence
* Third party report
 |

**Suggested Methods of Instruction**

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

**Recommended Resources**

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

# COMMON UNITS OF LEARNING

## TECHNICAL DRAWING

**UNIT CODE: ENG/CU/WEF/CC/01/6/A**

**Relationship to Occupational Standards**

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

**Duration of Unit:** 150 hours

**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 plain geometry drawings, solid geometry drawings, pictorial and orthographic drawings of components and application of CAD packages.

**Summary of Learning Outcomes**

1. Use and maintain drawing equipment and materials
2. Produce plain geometry drawings
3. Produce solid geometry drawings
4. Produce pictorial and orthographic drawings of components
5. Apply CAD packages

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Use and maintain drawing equipment and materials
 | * Identification and care of drawing equipment
* Identification and care of drawing materials
* Reference to

manufacturer’s instructions an work place procedures environmental legislations on use and maintenance of drawing equipment and materials * Use of Personal Protective Equipment (PPEs)
 | * Observation
* Oral questioning
* Written tests
 |
| 1. Produce plain geometry drawings
 | * Types of lines in drawings
* Construction of geometric forms
* Construction of different angles
* Measurement of different angles
* Bisection of different angles and lines
* Standard drawing conventions
 | * Oral questioning
* Written tests
* Observation
 |
| 1. Produce solid geometry drawings
 | * Interpretation of sketches and drawings of patterns e.g. cylinders, prisms and pyramids
* Development of surface of interpenetrating solids and truncated solids
* Interpenetrations of solids e.g. cylinder to cylinder and cylinder to prism or prism to prism of equal and unequal diameters
 | * Observation
* Written tests
* Oral questioning
 |
| 1. Produce pictorial and orthographic drawings of components
 | * Meaning of pictorial and orthographic drawings and sectioning
* Meaning of symbols and abbreviations
* Drawing of isometric, oblique, axonometric, auxiliary and perspective views
* Drawing of first and third angle projections
* Sectioning of components
* Free hand sketching of tools, equipment, components, geometric forms and diagrams
 | * Observation
* Written test
* Oral test
 |
| 1. Apply CAD packages in drawing
 | * Meaning and types of CAD e.g.
* Auto CAD
* Archi CAD
* Solid works
* Inventor
* Circuit maker
* Electronic work bench
* 2D and 3Ddrafting technique
 | * Practical
* Observation
* Written tests
 |

**Suggested Methods of Instruction**

* Projects
* Demonstration
* Practice by the trainee
* Field trips
* Group discussions
* Direct instructions

**Recommended Resources**

* + Drawing room
	+ Computer lab
	+ Drawing equipment and materials
	+ Computers
	+ CAD package
	+ Overhead projector

## ENGINEERING MATHEMATICS

**UNIT CODE: ENG/CU/WEF/CC/02/6/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply engineering mathematics

**Duration of Unit:** 150 hours

**Unit Description**

This unit describes the competencies required 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.

**Summary of Learning Outcomes**

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

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + 1. Apply Algebra
 | * Base and Index
* Law of indices
* Indicial equations
* Laws of logarithm
* Logarithmic equations
* Conversion of bases
* Use of calculator
* Reduction of equations
* Solution of equations reduced to quadratic form
* Solutions of simultaneous linear equations in three unknowns
* Solutions of problems involving AP and GP
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * + 1. Apply Trigonometry and hyperbolic functions
 | * Half -angle formula
* Factor formula
* Trigonometric functions
* Parametric equations
* Relative and absolute measures
* Measures calculation
* Definition of hyperbolic equations
* Properties of hyperbolic functions
* Evaluations of hyperbolic functions Hyperbolic identities
* Osborne’s Rule
* Ashx+bshx=C equation
* One-to-one relationship in functions
* Inverse functions for one-to-one relationship
* Inverse functions for trigonometric functions
* Graph of inverse functions
* Inverse hyperbolic functions
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * + 1. Apply complex numbers
 | * Definition of complex numbers
* Stating complex numbers in numbers in terms of conjugate argument and
* Modulus
* Representation of complex numbers on the Argand diagram
* Arithmetic operation of complex numbers Application of De Moivre’s theorem
* Application of complex numbers to engineering
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |
| * + 1. Apply Coordinate Geometry
 | * Polar equations
* Cartesian equation
* Graphs of polar equations
* Normal and tangents
* Definition of a point
* Locus of a point in relation to a circle
* Loci of points for given mechanism
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * + 1. Carry out Binomial Expansion
 | * Binomial theorem Power series using binomial theorem Roots of numbers using binomial theorem.
* Estimation of errors of small changes using binomial theorem.
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * + 1. Apply Calculus
 | * Definition of derivatives of a function
* Differentiation from fist principle
* Tables of some common derivatives
* Rules of differentiation
* Rate of change and small change
* Stationery points of functions of two variables
* Definition of integration
* Indefinite and definite integral
* Methods of integration application of integration.
* Integrals of hyperbolic and inverse functions
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * + 1. Solve Ordinary differential equations
 | * Types of first order differential equations
* Formation of first order differential equation
* Solution of first order differential equations
* Application of first order differential equations
* Formation of second order differential equations for various systems
* Solution of second order differential equations
* Application of second order differential equations
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * + 1. Carry out Mensuration
 | * Units of measurements
* Perimeter and areas of regular figures
* Volume of regular solids
* Surface area of regular solids
* Area of irregular figures
* Areas and volumes using Pappus theorem
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * + 1. Apply Power Series
 | * Definition of the term power series
* Taylor’s theorem
* Deduction of McLaurin’s theorem to obtain power series
* Application of Taylor’s theorem and McLaurin’s theorems in numerical work
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * + 1. Apply Statistics
 | * Measures of central tendency mean, mode and median
* Measures of dispersion

Variance and standard deviation* Definition of probability
* Laws of probability
* Expectation variance and S.D.
* Types of distributions
* Mean, variance and SD of probability distributions
* Application of probability distributions
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
* Simulation
* Data modelling
 |
| * + 1. Apply Numerical methods
 | * Definition of interpolation and extrapolation
* Application of interpolation
* Application of interactive methods to solve equations
* Application of interactive methods to areas and volumes
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |
| * + 1. Apply Vector theory
 | * Vectors and scalar in two and three dimensions
* Operations on vectors: Addition and Subtraction
* Position vectors
* Resolution of vectors
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |
| * + 1. Apply Matrix methods
 | * Matrix operation
* Determinant of 3x3 matrix
* Inverse of 3x3 matrix
* Solution of linear simultaneous equations in 3 unknown
* Application of matrices
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |

**Suggested Methods of Instruction**

* Group discussions
* Demonstration by trainer
* Exercises by trainee

**Recommended Resources**

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

## MECHANICAL SCIENCE PRINCIPLES

**UNIT CODE: ENG/CU/WEF/CC/03/06/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Mechanical science principles

**Duration of Unit:** 75 hours

**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.

**Summary of Learning Outcomes**

1. Determine forces in a system
2. Demonstrate knowledge of moments
3. Understand friction principles
4. Understand motions in engineering
5. Describe work, energy and power
6. Perform machine calculations
7. Demonstrate gas principles
8. Apply heat knowledge
9. Apply density knowledge
10. Apply pressure principles

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Determine

forces in a system  | * Define force
* State and explain force theorems
* Calculation of resultant of co-planar forces
* Resolve the forces
* Calculate the resultant force and equilibrium
* Discuss the application of different forces
 | * Written tests
* Oral
* questioning
* Assignments
* Supervised exercises
 |
| 1. Demonstrate knowledge of moments
 | * Define moments
* Explain the principle of moments
* Calculation of couples
* Calculation of moments of
* a force,
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| 1. Understand friction

principles  | * Definition of mechanical properties of materials
* Draw the stress strain graph
* Discuss application of material depending on their properties
* Discuss effect of environmental factors on material properties.
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |
| 1. Understand motions in engineering
 | * Discussion of Pascal’s principles
* Measuring fluid parameters
* State the laws of gases
* Discuss properties of water and steam
 | * Assignments
* Oral questioning
* Practical tests
* Observation
* Supervised exercises
* Written tests
 |
| 1. Describe work, energy and power
 | * Uses and working principle of Gear trains
* Uses and working principles of Pulley system,
* hoists and lifts
* Uses and working principles of screws
 | * Assignments
* Supervised exercises
* Written tests
* Practical test
 |
| 1. Perform machine calculations
 | * Definition of machine
* Principle of machine calculation
* Fundamentals of a machine
* Dimensional units
 | * Assignments
* Supervised exercises
* Written tests
 |
| 1. Demonstrate gas principles
 | * Gas flow equations between parallel surfaces
* Gas equations in circular pipes
* Application of gas equations
 | * Assignments
* Supervised exercises
* Written tests
* Practical test
 |
| 1. Apply heat knowledge
 | * Meaning of heat
* Heat calculations
 | * Assignments
* Supervised
 |
| 1. Apply density knowledge
 | * Assignments
* Supervised exercises
* Written tests
* Practical test
 | * Assignments
* Supervised exercises
* Written tests
 |
| 1. Apply pressure principles
 | * Meaning of pressure
* Pressure calculations
* Application of pressure principles
 | * Assignments
* Supervised exercises
* Written tests
 |

**Suggested Methods of Instruction**

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

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* Electrical workshop
* Relevant practical materials
* Dice
* Computers with internet connection

## FLUID MECHANICS PRINCIPLES

**UNIT CODE: ENG/CU/WEF/CC/04/6/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply fluid mechanics principles

**Duration of Unit:** 75 hours

**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.

**Summary of Learning Outcomes**

1. Understand flow of fluids
2. Demonstrate knowledge in viscous flow
3. Perform dimensional analysis
4. Operate fluid pumps

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Understand flow of fluids
 | * Flow rate in pipes is
* Losses in pipes are determined
* Causes of losses in pipes
* Flow losses equations
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| 1. Demonstrate knowledge in viscous flow
 | * + Viscous flow between parallel surfaces
	+ Viscous flow equations between parallel surfaces
	+ Viscous flow equations in circular pipes
* Application of viscous flow equations
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| 1. Perform dimensional analysis
 | * + Dimensional analysis definition
	+ Principle of dimensional homogeneity
	+ Fundamental dimensions
	+ Dimensional units
	+ Physical quantities
* Application of dimensional analysis
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |
| 1. Operate fluid pumps
 | * Principle of operation of pumps
* Deriving Reciprocating pump equation
* Deriving Centrifugal pump equation
* Application of Pump equation in problem solving
 | * Assignments
* Oral questioning
* Practical tests
* Observation
* Supervised exercises
* Written tests
 |

**Suggested Methods of Instruction**

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

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* Relevant practical materials
* Dice
* Computers with internet connection

## THERMODYNAMICS PRINCIPLES

**UNIT CODE: ENG/CU/WEF/CC/05/6/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply thermodynamics principles

**Duration of Unit:** 75 hours

**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.

**Summary of Learning Outcomes**

1. Understand fundamentals of thermodynamics
2. Perform steady flow processes
3. Perform non-steady flow processes
4. Understand perfect gases
5. Generate steam
6. Perform thermodynamics reversibility and entropy
7. Understand idea gas cycle
8. Demonstrate fuel and combustion
9. Perform heat transfer
10. Understand heat exchangers
11. Understand air compressors
12. Understand gas turbines
13. Understanding impulse steam turbines

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Understand fundamentals of thermodynamics
 | * + Terms used in thermodynamics
	+ Thermodynamics processes and cycles
* First law of thermodynamics
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| 1. Perform steady flow processes
 | * + Deriving Steady flow energy equation
	+ Applying Steady flow energy equation
	+ Application of Steady flow energy equation in utilities
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| 1. Perform non-steady flow processes
 | * + Deriving non-flow energy equation
* Application of Non-flow energy equation in problem solving
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |
| 1. Understand perfect gases
 | * + State Perfect gas laws
	+ Carrying out Gas laws experiment
* Application of Gas laws
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |
| 1. Generate steam
 | * + Determining Dryness fraction
	+ Determining Relationship between pressure and boiling point
	+ Carrying out Energy balance
	+ Determining Relationship between temperature and pressure
 | * Assignments
* Oral questioning
* Practical tests
* Observation
* Supervised exercises
 |
| 1. Perform thermodynamics reversibility and entropy
 | * + Thermodynamics reversibility principles
	+ Principles of heat engine
	+ Second law of thermodynamics
	+ Entropy in thermodynamics
 | * Assignments
* Oral questioning
* Observation
* Supervised exercises
 |
| 1. Understand idea gas cycle
 | * + Ideal gas cycle processes
	+ Air standard efficiency and actual efficiency are differentiated
	+ Problems are solved in ideal gas cycle
 | * Oral questioning
* Practical tests
* Observation
* Supervised exercises
 |
| 1. Demonstrate fuel and combustion
 | * + Classification of fuels
	+ Properties of fuels
	+ Deriving of Combustion equation
	+ Application of Combustion equation
 | * Oral questioning
* Practical tests
* Observation
* Supervised exercises
 |
| 1. Perform heat transfer
 | * + Deriving Conduction equation from Fourier’s law
	+ Heat transfer equation is derived and applied from Newton’s law of cooling and Fourier’s law
 | * Oral questioning
* Practical tests
* Observation
* Supervised exercises
 |
| 1. Understand heat exchangers
 | * + Classification of Heat exchangers
	+ Recuperative heat exchangers are described
	+ Application of Heat equations
 | * Assignments
* Oral questioning
* Practical tests
* Observation
* Supervised exercises
 |
| 1. Understand air compressors
 | * + Classification of Air compressors
	+ Types of air compressors
	+ Deriving and applying Equations of reciprocating compressors
 | * Assignments
* Oral questioning
* Practical tests
* Observation
* Supervised exercises
 |
| 1. Understand gas turbines
 | * + Theoretical cycle for gas turbines
	+ Open cycle gas turbine
	+ Closed cycle gas turbine
	+ Deriving Gas turbine equations
 | * Assignments
* Oral questioning
* Practical tests
* Observation
* Supervised exercises
 |
| 1. Understanding impulse steam turbines
 | * + Principles of operations of the impulse steam turbines
	+ Deriving and applying Impulse steam turbine equation
 | * Assignments
* Oral questioning
* Practical tests
* Observation
* Supervised exercises
 |

**Suggested Methods of Instruction**

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

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* Relevant practical materials
* Dice
* Computers with internet connection

## MATERIAL SCIENCE AND PERFORM METALLURGICAL PROCESSES

**UNIT CODE:** ENG/CU/WEF/CC/06/6

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply material science and perform metallurgical processes

**Duration of Unit:** 75 hours

**Unit Description:**

The learner will be introduced to performing material testing and metallurgical processes. It involves analysing properties of engineering materials, performing extraction processes, producing iron materials, ceramics, composites and alloys, performing heat treatment, material testing and identifying corrosion and its prevention

**Summary of Learning Outcomes**

1. Analyze properties of engineering materials
2. Perform ore extraction processes
3. Produce iron materials
4. Produce alloy materials
5. Produce non-ferrous materials
6. Produce ceramics materials
7. Produce composite materials
8. Utilise other engineering materials
9. Perform heat treatment
10. Perform material testing
11. Prevent material corrosion

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + Analyze properties of engineering materials
 | * + Engineering materials is identified as per the procedures
	+ Physical properties of engineering material
	+ Mechanical properties of engineering materials
* Crystal structure of materials
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * + Perform ore extraction processes
 | * Safety measures in metal extraction
* Method of metal extraction
* Procedure in metal extraction processes
* Storing of metal Extraction by- products
* Disposing extraction by- products
 | * Written tests
* Oral questioning
* Assignments
* Supervised exercises
 |
| * + Produce iron materials
 | * Ore smelting processes.
* Composition of iron
* Method of producing iron material
* Refinement processes
 | * Assignments
* Oral questioning
* Supervised exercises
* Written tests
 |
| * + Produce alloy materials
 | * + Tools and equipment for alloy production
	+ Alloy formation process
* Testing alloy products quality
 | * Assignments
* Oral questioning
* Practical tests
* Observation
* Supervised exercises
* Written tests
 |
| * + Produce non-ferrous materials
 | * + Extraction of Non-ferrous materials
	+ Smelting and purifying of extracted non-ferrous material
	+ Testing Non-ferrous material
	+ Identifying Alloying elements for non-ferrous materials
	+ Alloy formation process
	+ Testing of Alloys for non-ferrous material
 | * Assignments
* Supervised exercises
* Written tests
* Practical test
 |
| * + Produce ceramics materials
 | * + Composition of ceramic materials
	+ Manufacturing process for ceramics
	+ Production of Ceramic materials
	+ Finishing processes for ceramic materials
 | * Assignments
* Supervised exercises
* Written tests
* Practical test
 |
| 1. Produce composite materials
 | * + Types of composites
	+ Elements involve in composite formation
	+ Formation process of composites
	+ Testing of composite materials
 | * Assignments
* Supervised exercises
* Written tests
* Practical test
 |
| 1. Utilise other engineering materials
 | * + Identifying and selecting engineering materials
	+ Developing operation plan
	+ Setting up production machine
	+ Setting production parameters
	+ Production process for engineering materials
 | * Assignments
* Supervised exercises
* Written tests
* Practical test
 |
| 1. Perform heat treatment
 | * + Safety practices procedures
	+ Heat treatment processes
	+ Procedure in heat treatment processes
	+ Operations of heat treatment of metals
 | * Assignments
* Supervised exercises
* Written tests
* Practical test
 |
| 1. Perform material testing
 | * + Material testing methods
	+ Procedure of material testing
	+ Analyzing material testing results
	+ Material testing equipment are taken care of and maintained.
 | * Assignments
* Supervised exercises
* Written tests
* Practical test
 |
| 1. Corrosion and its prevention
 | * + Safety observation during corrosion prevention
	+ Corrosion type is identified
	+ Causes of corrosion
	+ Methods of corrosion prevention
	+ Corrosion prevention
 | * Assignments
* Supervised exercises
* Written tests
* Practical test
 |

**Suggested Methods of Instruction**

* Demonstration by trainer
* Discussions
* Practical work by trainee(s)
* Exercises
* Industrial visits
* YouTube for teaching/learning and inspiration
* Simulation
* Power point presentation

**Recommended Resources**

**Tools and equipment**

* Measuring tools and gauges
* Marking out tools
* Inspection tools and equipment
* Dressing tools
* Firefighting equipment

**Materials and supplies**

* PPEs –dust coat, dust masks, ear muffs, goggles
* First Aid kit
* Brooms and cleaning stuff
* Cleaning detergents
* Drawing papers

# CORE UNITS OF LEARNING

## SOLDERING AND GAS WELDING

**UNIT CODE: ENG/CU/WEF/CR/01/6/A**

**Relationship to Occupational Standards**

This unit of learning addresses the unit of competency: Perform soldering and gas welding

**Duration of Unit:**180 hours

**Unit Description**

This unit specifies competencies required for setting up equipment and materials, carrying out soldering process, setting up gas welding equipment and materials, carrying out gas welding, setting up gas cutting equipment and materials and carrying out gas cutting operation

**Summary of Learning Outcomes**

1. Set up soldering equipment and materials
2. Carry out soldering process
3. Set up gas welding equipment and materials
4. Carry out gas welding
5. Set up gas cutting equipment and materials
6. Carry out gas cutting operation

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Set up soldering equipment and materials
 | * Observation of safety in soldering
* Interpretation of working drawings
* Identification and selection of materials, tools and equipment
* Joint preparation
* Steps of setting up soldering tools and equipment
 | * Observation
* Oral questioning
* Written tests
 |
| 1. Carry out soldering process
 | * Observation of safety in soldering
* Types of soldering processes
	+ Soft soldering
	+ Hard soldering (brazing)
* Types and uses of solders and fluxes
* Soft soldering process
* Hard soldering process
* Advantages and limitations of soft and hard soldering
* Applications of soldering
* Soldering workplace housekeeping
	+ Workstation cleaning
	+ Care and storage of tools and equipment
	+ Waste disposal
 | * Observation
* Oral questioning
* Product checklist
* Projects
 |
| 1. Set up gas welding equipment and materials
 | * Observation of safety in gas welding
* Interpretation of working drawings
* Selection of materials, equipment and accessories
* Joint preparation
* Steps of setting up gas welding equipment and accessories
 | * Observation
* Oral questioning
* Written tests
* Practical tests
 |
| 1. Carry out gas welding
 | * Observation of safety in gas welding
* Gas welding equipment and accessories
	+ Use
	+ Care and maintenance
* Welding gases
	+ Oxygen
	+ Fuel gas( Acetylene)
* Procedure for lighting and shutting off gas welding flame
* Types of gas welding flames
* Welding joints, symbols and abbreviations
* Uses of filler metals
* Gas welding materials
1. Mild steel
2. Shapes of materials
	* + Plates
		+ Tubes
		+ Metal sheets
		+ Pipes
		+ Flat bars
		+ Spring bars
* Gas welding process
* Gas welding techniques/patterns
* Welding positions
* Gas welding defects and remedies
* Advantages and limitations of gas welding
* Applications of gas welding
* Visual inspection of the weld(ISO 17637 standard)
* Gas welding workplace housekeeping
	+ Workstation cleaning
	+ Care and storage of tools and equipment
	+ Waste disposal
 | * Observation
* Product checklist
* Oral questioning
* Written tests
* Projects
 |
| 1. Set up gas cutting equipment and materials
 | * Observation of safety in gas cutting
* Interpretation of working drawings
* Selection of materials, equipment and accessories
* Setting up gas cutting torch
 | * Observation
* Oral questioning
* Written tests
 |
| 1. Carry out gas cutting operation
 | * Observation of safety in gas cutting
* Gas cutting equipment and accessories
* Gas cutting process
* Gas cutting defects, causes and remedies
* Features of a quality kerf
* Gas cutting workplace housekeeping
	+ Workstation cleaning
	+ Care and storage of tools and equipment
	+ Waste disposal
 | * Observation
* Product checklist
* Oral questioning
* Written tests
* Projects
 |

**Suggested Methods of Instruction**

* Facilitation of theory by trainer
* Demonstration of task by trainer
* Practice by trainee
* Viewing videos of soldering, brazing, oxy-acetylene welding and cutting process
* Industrial visits

**Recommended Resources**

* Personal Protective Equipment (PPE)
* Welding suit (fire proof)
* Gas /soldering welding goggles
* Special fire proof head cap
* Safety boots
* Gas welding gloves
* Welding Apron
* Soldering tools and equipment
* Welding bay /booth
* Gas manifold system/ trolleys
* Gas welding equipment and accessories
* Gas cutting equipment and accessories
* Gas welding consumables
	+ Filler metals
* Gas welding materials
	+ Mild steel
* Soldering and brazing materials
	+ Mild steel
* Soldering consumables
	+ Soldering flux
	+ Brazing rods and solders
	+ Brazing fluxes
* Finishing tools and equipment
* Video clips

## MANUAL METAL ARC WELDING

**UNIT CODE: ENG/CU/WEF/CR/02/6/A**

**Relationship to Occupational Standards**

This unit of learning addresses the unit of competency: Perform manual metal arc welding

**Duration of Unit:** 360 hours

**Unit Description**

This unit specifies competencies required for material preparation, setting up of Manual Metal Arc (MMA) welding equipment and application of safety in welding. It also includes competencies in thermal joining of metals using mild steel

**Summary of Learning Outcomes**

1. Set up MMA equipment and materials
2. Carry out MMA welding

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Set up MMA equipment and materials
 | * Observation of safety in manual metal arc welding
* Interpretation of working drawings
* Selection of materials, tools and equipment
* Joint preparation
* Steps of setting up MMA equipment
 | * Observation
* Oral questioning
* Written tests
 |
| 1. Carry out MMA welding
 | * Observation of safety in MMA
* Types of MMA equipment and accessories
* AC/DC welding polarity
* Principle of MMA welding process
* MMA welding specification procedure
* Methods of striking an arc
* Types and uses of electrodes
* Care and storage of electrodes
* Factors affecting quality of weld
	+ Arc length
	+ Travel speed
	+ Current setting/amperage
	+ Angle of electrode
* Manual metal arc welding process of:
	+ Mild steel(ISO 9606-1)
* Welding joints, symbols and positions
* Welding patterns
* MMA welding defects, causes and remedies
* Visual inspection (ISO 17637)
* Post weld treatment
	+ Heat treatment
	+ Peening
	+ Dressing
* Advantages and limitations of MMA welding
* Applications of MMA welding
* MMA welding workplace housekeeping
	+ Workstation cleaning
	+ Care and storage of tools and equipment
	+ Waste disposal
 | * Observation
* Product checklist
* Oral questioning
* Written tests
* Projects
 |

**Suggested Methods of Instruction**

* Facilitation of theory by trainer
* Demonstration of task by trainer
* Practice by trainee
* Viewing videos of MMA welding
* Industrial visits

**Recommended Resources**

* Personal Protective Equipment
* Welding suit (fire proof)
* MMA welding goggles
* Special fire proof head cap
* Safety boots
* MMA welding gloves
* Ear plugs
* Welding Apron
* Welding bay/welding booth
* MMA welding tools, equipment and accessories
* MMA cutting equipment and accessories
* MMA weldable materials
	+ Mild steel
* MMA consumables
	+ MMA electrodes
* Video clips on MMA welding and cutting
* Heat treatment furnace

## TUNGSTEN INERT GAS (TIG) WELDING

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

**Relationship to Occupational Standards**

This unit of learning addresses the unit of competency: Perform TIG welding

**Duration of Unit:**180 hours

**Unit Description**

This unit specifies competencies required for material preparation, setting up of Tungsten Inert Gas (TIG) welding equipment and application of safety. It involves competencies for thermal joining of metals using non-consumable electrodes.

**Summary of Learning Outcomes**

1. Set up TIG equipment and materials
2. Carry out TIG welding

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Set up TIG equipment and materials
 | * Observation of safety in TIG welding
* Interpretation of working drawings
* Welding specification procedure
* Selection of materials, tools and equipment
* Joint preparation
* Steps of setting up TIG equipment
 | * Observation
* Oral questioning
* Written tests
 |
| 1. Carry out TIG welding
 | * Observation of safety in TIG welding
* TIG equipment and accessories
* AC/DC welding polarity
* Principle of TIG welding process
* Electrodes materials and their

application* Factors affecting quality of weld
	+ Arc length
	+ Travel speed
	+ Current setting/amperage
	+ Angle of welding gun
* TIG welding process of:
	+ Mild steel(ISO 9606-1)
	+ Alloy steel(ISO 9606 -1)
* Welding joints, symbols and positions
* TIG welding defects, causes and remedies
* Advantages and limitations of TIG welding
* TIG welding specification procedure
* Visual inspection ISO 17637 standard
* TIG welding workplace housekeeping
	+ Workstation cleaning
	+ Care and storage of tools and equipment
	+ Waste disposal
 | * Observation
* Product checklist
* Oral questioning
* Projects
 |

**Suggested Methods of Instruction**

* Facilitation of theory by trainer
* Demonstration of task by trainer
* Practice by trainee
* Viewing videos of TIG welding
* Industrial visits

**Recommended Resources**

* Personal Protective Equipment
* Welding suit/ (fire proof)
* TIG welding goggles
* Special fire proof head cap
* Safety boots
* TIG welding gloves
* Ear plugs
* Welding bay/welding booth
* TIG welding tools, equipment and accessories
* TIG weldable materials
	+ Mild steel
	+ Alloy steel
* Video clips on TIG welding

## METAL ACTIVE GAS (MAG) WELDING

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

**Relationship to Occupational Standards**

This unit of learning addresses the unit of competency: Perform MAG welding

**Duration of Unit:**180 hours

**Unit Description**

This unit specifies competencies required for material preparation, setting up of Metal Active Gas (MAG) welding equipment and application of safety. It also includes competencies in thermal joining of metals using consumable electrodes.

**Summary of Learning Outcomes**

1. Set up MAG equipment and materials
2. Carry out MAG welding

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Set up MAG equipment and materials
 | * Observation of safety in MAG welding
* Interpretation of working drawings
* Selection of materials, tools and equipment
* Joint preparation
* Steps of setting up MAG equipment
 | * Observation
* Oral questioning
* Written tests
 |
| 1. Carry out MAG welding
 | * Observation of safety in MAG welding
* MAG equipment and accessories
* AC/DC welding polarity
* MAG welding specification procedure
* Principle of MAG welding process
* Electrodes wire feed mechanism
* Factors affecting quality of weld:
	+ Arc length
	+ Travel speed
	+ Current setting/amperage
	+ Angle of welding gun
* MAG welding process of:
	+ mild steel(ISO 9606-1)
* Welding joints, symbols and positions
* MAG welding defects, causes and remedies
* Advantages and limitations of MAG welding
* Visual inspection ISO 17637
* MAG welding workplace housekeeping
	+ Workstation cleaning
	+ Care and storage of tools and equipment
	+ Waste disposal
 | * Observation
* Product checklist
* Oral questioning
* Projects
 |

**Suggested Methods of Instruction**

* Facilitation of theory by trainer
* Demonstration of task by trainer
* Practice by trainee
* Viewing videos of MAG welding
* Industrial visits

**Recommended Resources**

* Personal Protective Equipment
* Welding suit (fire proof)
* MAG welding goggles
* Special fire proof head cap
* Safety boots
* MAG welding gloves
* Ear plugs
* Welding Apron
* Welding bay/welding booth
* MAG welding tools, equipment and accessories
* MAG weldable materials
	+ Mild steel
* Video clips on MAG welding

## SPOT AND SEAM RESISTANCE WELDING

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

**Relationship to Occupational Standards**

This unit of learning addresses the unit of competency: Perform spot and seam welding processes

**Duration of Unit:** 90 hours

**Unit Description**

This unit of learning specifies competencies required for material preparation, setting up of spot and seam welding equipment and application of safety in spot and seam welding. It also includes competencies in thermal joining of metals using two copper electrodes and pressure.

**Summary of Learning Outcomes**

1. Set up of spot equipment and materials
2. Carry out spot welding
3. Set up of seam equipment and materials
4. Carry out seam welding

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Set up spot equipment and materials
 | * Observation of health and safety in spot welding
* Interpretation of working drawing
* Selection of materials, tools and equipment
* Joint edge preparation
* Steps of setting up spot tools and equipment
 | * Observation
* Oral questioning
* Written tests
 |
| 1. Carry out spot welding
 | * Observation of health and safety in spot welding
* Spot equipment and accessories
* Spot welding specification procedure
* Principle spot welding process
* Advantages and limitations of spot welding
* Factors affecting quality of weld
	+ Current setting/amperage
	+ Time
	+ Pressure
* Spot welding process
* Visual inspection
* Spot welding defects, causes and remedies
* Spot welding workplace housekeeping
	+ Workstation cleaning
	+ Care and storage of tools and equipment
	+ Waste disposal
* Spot welding of mild steel(ISO 9606-1)
 | * Observation
* Product checklist
* Oral questioning
* Projects
 |
| 1. Set up seam equipment and materials
 | * Observation of health and safety in spot welding
* Interpretation of working drawing
* Selection of materials, tools and equipment
* Joint edge preparation
* Steps of setting up spot tools and equipment
 | * Observation
* Oral questioning
* Written tests
 |
| 1. Carry out seam welding
 | * Observation of health and safety in spot welding
* Seam equipment and accessories
* Seam welding specification procedure
* Principle seam welding process
* Advantages and limitations of seam welding
* Visual inspection
* Factors affecting quality of weld
	+ Current setting/amperage
	+ Time
	+ Pressure
* Seam welding process
* Seam welding defects, causes and remedies
* Seam welding workplace housekeeping
	+ Workstation cleaning
	+ Care and storage of tools and equipment
	+ Waste disposal
* Seam welding of mild steel
 | * Observation
* Product checklist
* Oral questioning
* Projects
 |

**Suggested Methods of Instruction**

* Trainer led facilitation of theory
* Demonstration of task by trainer
* Practice by trainee
* Industrial visits
* Viewing videos of spot and seam welding

**Recommended Resources**

* Personal Protective Equipment
* Welding suit (fire proof)
* Safety goggles
* Special fire proof head cap
* Safety boots
* Spot and seam welding gloves
* Ear plugs
* Welding Apron
* Welding bay/welding booth
* Spot and Seam welding tools, equipment and accessories
* Spot and seam welding materials
	+ Mild steel
* Video clips on spot and seam welding

## UNDERWATER ARC WELDING

**UNIT CODE: ENG/CU/WEF/CR/06/6/A**

**Relationship to Occupational Standards**

This unit of learning addresses the unit of competency: Perform underwater arc welding

**Duration of Unit:**90 hours

**Unit Description**

This unit specifies competence required to prepare materials, set up for underwater arc welding equipment and application of safety precautions in underwater arc welding. It also includes competencies for using arc welding and cutting process in underwater fabrication works.

**Summary of Learning Outcomes**

1. Set up underwater arc welding equipment and materials
2. Carry out underwater arc welding

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Set up underwater arc welding equipment and materials
 | * Observation of health and safety in underwater arc welding
* Interpretation of working drawing
* Selection of materials, tools and equipment
* Joint edge preparation
* Steps of setting up underwater tools and equipment
 | * Observation
* Oral questioning
* Written tests
 |
| 1. Carry out underwater arc welding
 | * Observation of health and safety in underwater arc welding
* Underwater arc equipment and accessories
* Underwater arc welding specification procedure
* Principle of underwater arc welding process
* Advantages and limitations of underwater arc welding
* Factors affecting quality of weld includes;
	+ Current setting/amperage
	+ Travel speed
	+ Polarity type
* Underwater arc welding process
* Methods of underwater arc welding process
	+ Wet welding
	+ Dry welding
* Underwater arc welding defects, causes and remedies
* Visual Inspection
* Underwater arc welding safety procedures
* Care and maintenance of underwater arc welding
* Waste disposal
* Underwater arc welding of mild steel (ISO 9606-1)
 | * Observation
* Product checklist
* Oral questioning
* Projects
 |

**Suggested Methods of Instruction**

* Trainer led facilitation of theory
* Demonstration of task by trainer
* Practice by trainee
* Industrial visits
* Viewing videos of underwater arc welding

**Recommended Resources**

* Personal Protective Equipment
* Welding suit (fire proof and water resistant)
* Under water arc welding goggles
* Special fire proof head cap
* Safety boots
* Under water arc welding gloves
* Ear plugs
* Welding Apron
* Underwater arc welding space
* Underwater arc welding tools, equipment and accessories
* Underwater consumables
	+ Electrodes
* Underwater arc welding materials including;
	+ Mild steel
* Video clips on underwater arc welding

## SUBMERGED ARC WELDING

**UNIT CODE: ENG/CU/WEF/CR/07/6/A**

**Relationship to Occupational Standards**

This unit of learning addresses the unit of competency: Perform submerged arc welding

**Duration of Unit:** 90 hours

**Unit Description**

This unit specifies competencies required to prepare materials, set up for submerged arc welding equipment and application of safety in submerged arc welding. It also includes competencies for welding with an electric arc beneath a bed of granulated flux.

**Summary of Learning Outcomes**

1. Set up submerged arc welding equipment and materials
2. Carry out submerged arc welding
3. Set up electro-slag arc welding equipment and materials
4. Carry out electro-slag arc welding

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Set up submerged arc welding equipment and materials
 | * Observation of health and safety in submerged arc welding
* Interpretation of working drawing
* Selection of materials, tools and equipment
* Joint edge preparation
* Steps of setting up submerged tools and equipment
 | * Observation
* Oral questioning
* Written tests
 |
| 1. Carry out submerged arc welding
 | * Observation of health and safety in submerged arc welding
* Submerged arc welding specification procedure
* Submerged arc equipment and accessories
* Submerged arc welding specification procedure
* Principle of submerged arc welding process
* Advantages and limitations of submerged arc welding
* Visual inspection ISO 17637
* Factors affecting quality of weld includes;
	+ Current setting/amperage
	+ Travel speed
	+ Polarity type
* Submerged arc welding process
* Submerged arc welding defects, causes and remedies
* Submerged arc welding workplace housekeeping
	+ Workstation cleaning
	+ Care and storage of tools and equipment
	+ Waste disposal
* Submerged arc welding of mild steel(ISO 9606-1)
 | * Observation
* Product checklist
* Oral questioning
* Projects
 |
| 1. Set up electro-slag arc welding equipment and materials
 | * Observation of health and safety in electro-slag electro-slag arc welding
* Interpretation of working drawing
* Selection of materials, tools and equipment
* Joint edge preparation
* Steps of setting up electro-slag tools and equipment
 | * Observation
* Product checklist
* Oral questioning
* Projects
 |
| 1. Carry out electro-slag arc welding
 | * Observation of health and safety in electro-slag arc welding
* Electro-slag welding specification procedure
* Electro-slag welding specification
* electro-slag arc equipment and accessories
* Principle of electro-slag arc welding process
* Advantages and limitations of electro-slag arc welding
* Factors affecting quality of weld includes;
	+ Current setting/amperage
	+ Travel speed
	+ Polarity type
* Electro-slag arc welding process
* Electro-slag arc welding defects, causes and remedies
* Visual Inspection ISO 17637
* Electro-slag arc welding workplace housekeeping
	+ Workstation cleaning
	+ Care and storage of tools and equipment
	+ Waste disposal
* Electro-slag arc welding of mild steel (ISO 9606-1)
 | * Observation
* Product checklist
* Oral questioning
* Projects
 |

**Suggested Methods of Instruction**

* Trainer led facilitation of theory
* Demonstration of task by trainer
* Practice by trainee
* Industrial visits
* Viewing videos of submerged and electro-slag arc welding

**Recommended Resources**

* Personal Protective Equipment
	+ Welding suit (fire proof)
	+ Submerged arc welding goggles
	+ Special fire proof head cap
	+ Safety boots
	+ Submerged arc welding gloves
	+ Electro-slag arc welding gloves
	+ Ear plugs
	+ Welding Apron
* Submerged arc welding space
* Submerged and Electro-slag arc welding tools, equipment and accessories
* Submerged and Electro-slag arc welding materials including;
	+ Mild steel
* Video clips on Submerged and electro-slag arc welding

## PLASMA AND LASER BEAM WELDING

**UNIT CODE: ENG/CU/WEF/CR/08/6/A**

**Relationship to Occupational Standards**

This unit of learning addresses the unit of competency: Perform plasma and laser beam welding

**Duration of Unit:** 90 hours

**Unit Description**

This unit of learning specifies competencies required to prepare materials, set up plasma and laser beam equipment, application of safety in use of constricted arc at high velocities and elevated temperatures (plasma) in welding and cutting. It also includes competencies for use of concentrated light rays energy (laser beam) in welding and cutting.

**Summary of Learning Outcomes**

1. Set up plasma welding equipment and materials
2. Carry out plasma welding
3. Set up plasma cutting equipment and materials
4. Carry out plasma cutting
5. Set up laser welding equipment and materials
6. Carry out laser beam welding
7. Set up laser beam cutting equipment and materials
8. Carry out laser beam cutting

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Set up plasma welding equipment and materials
 | * Observation of health and safety in plasma welding
* Interpretation of working drawing
* Selection of materials, tools and equipment
* Joint edge preparation
* Steps of setting up plasma tools and equipment
 | * Observation
* Oral questioning
* Written tests
 |
| 1. Carry out plasma welding
 | * Observation of health and safety in submerged arc welding
* Plasma equipment and accessories
* Plasma welding specification
* Principle of plasma welding process
* Advantages and limitations of plasma welding
* Factors affecting quality of weld
* Plasma welding process
	+ Transferred
	+ Non-transferred
* Plasma welding defects, causes and remedies
* Plasma welding workplace housekeeping
	+ Workstation cleaning
	+ Care and storage of tools and equipment
	+ Waste disposal
* Plasma welding of mild steel (ISO 9606-1)
 | * Observation
* Product checklist
* Oral questioning
* Projects
 |
| 1. Carry out plasma cutting
 | * Observation of health and safety in plasma cutting
* Interpretation of working drawing
* Selection of materials, tools and equipment
* Plasma cutting process
 | * Observation
* Oral questioning
* Written tests
* Projects
 |
| 1. Set up laser beam welding equipment and materials
 | * Observation of health and safety in laser beam welding
* Interpretation of working drawing
* Selection of materials, tools and equipment
* Joint edge preparation
* Steps of setting up laser beam tools and equipment
 | * Observation
* Product checklist
* Oral questioning
* Projects
 |
| 1. Carry out laser beam welding
 | * Observation of health and safety in laser beam welding
* Laser beam equipment and accessories
* Laser beam welding specification
* Principle of laser beam welding process
* Advantages and limitations of laser beam welding
* Factors affecting quality of weld
* Laser beam welding defects, causes and remedies
* Laser beam welding workplace housekeeping
	+ Workstation cleaning
	+ Care and storage of tools and equipment
	+ Waste disposal
* Laser beam welding of mild steel (ISO 9606-1)
 | * Observation
* Product checklist
* Oral questioning
* Projects
 |

**Suggested Methods of Instruction**

* Trainer led facilitation of theory
* Demonstration of task by trainer
* Practice by trainee
* Industrial visits
* Viewing videos of plasma and laser beam welding and cutting

**Recommended Resources**

* Personal Protective Equipment
* Welding suit (fire proof)
* Plasma and laser welding goggles
* Special fire proof head cap
* Safety boots
* Plasma and arc welding gloves
* Electro-slag arc welding gloves
* Ear plugs
* Welding Apron
* Welding booth
* Plasma welding and cutting tools, equipment and accessories
* Laser beam welding and cutting tools, equipment and accessories
* Plasma welding and cutting materials including;
	+ Mild steel
* Laser beam welding and cutting materials including;
	+ Mild steel
* Video clips on plasma welding and cutting
* Video clips on laser beam welding and cutting

## WELDING INSPECTION AND QUALITY CONTROL

**UNIT CODE: ENG/CU/WEF/CR/09/6/A**

**Relationship to Occupational Standards**

This unit of learning addresses the unit of competency: perform welding inspection and quality control

**Duration of Unit:** 60 hours

**Unit Description**

This unit of learning specifies competencies required to perform quality control and inspection on welded products and structures while observing safety. It also includes competencies to document test results.

**Summary of Learning Outcomes**

1. Set up testing equipment and accessories
2. Carry out weld tests and inspection

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Set up testing equipment and accessories
 | * Observation of safety in testing of weld
* Description of weld test and inspection
* Significance of quality control
* Features of a quality weld
* Selection of testing materials, tools and equipment
* Preparation of materials for tests
* All slag removed
* Profile and dimensions
* No grinding on the root and the face side of the weld
* Stop and restart in the root run and capping run are identified
 | * Observation
* Product checklist
* Oral questioning
* Written tests
* Problem solving written tests
 |
| 1. Carry out weld tests and inspection
 | * Types of weld tests
	+ Destructive tests
	+ Non-destructive tests
* Advantages and limitations of weld tests
* Process of conducting weld tests
	+ Destructive tests
	+ Non-destructive tests
* International Organisation quality of weld Standards
* Documentation of test results
* Care, storage and maintenance of test tools and equipment
 | * Observation
* Product checklist
* Oral questioning
* Practical tests
* Problem solving written tests
* Trainee’s portfolio of evidence
 |

**Suggested Methods of Instruction**

* Trainer led facilitation of theory
* Demonstration of task by trainer
* Practice by trainee
* Industrial visits
* Viewing of videos of metal finishing processes

**Recommended Resources**

* Measuring and checking tools
* Marking out tools
* Forming tools
* Shaping tools
* Rolling tools
* Templates
* Cutting tools
* Finishing tools and equipment
* Video clips on electroplating

## DESIGN OF PRODUCTS AND STRUCTURES

**UNIT CODE: ENG/CU/WEF/CR/10/6/A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Design products and structures

**Duration of Unit:** 90 hours

**Unit Description**

This unit specifies competencies required for developing models and prototypes of products and structures, developing jigs and fixtures and planning production process.

**Summary of Learning Outcomes**

1. Develop models and prototypes of products and structures
2. Develop jigs and fixtures
3. Plan production process

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Develop models and prototypes of products and structures
 | * Design process
	+ Design cycle
	+ Design principles
* Design of models
* Working drawings development
* Model development
* Test of models
	+ Simulation
	+ Impact test
* Prototype development
* Innovation
 | * Observation
* Product checklist
* Oral questioning
* Written tests
 |
| 1. Develop jigs and fixtures
 | * Description of jigs and fixtures
* Types of jigs and fixtures
* Application of jigs and fixtures
* Design of jigs and fixtures
* Development of jigs and fixtures
 | * Observation
* Product checklist
* Oral questioning
* Written tests
 |
| 1. Plan production process
 | * Estimation of cost
* Production planning
* Production control
 | * Oral questioning
* Written tests
* Case studies
 |

**Suggested Methods of Instruction**

* Model simulation
* Trainer led facilitation of theory
* Demonstration of task by trainer
* Practice by trainee
* Industrial visits

**Recommended Resources**

* Computer Aided Design software
	+ Inventor
	+ Solid works
	+ AutoCAD
* Engineering drawing instruments
	+ T-Square
	+ Set squares (60o and 45o)
	+ Engineering drawing set
	+ Drawing boards
* Engineering drawing materials
* Samples of jigs and fixtures
* Pictures of products and structures
* Video clips of jigs and fixtures

## FABRICATION OF PRODUCTS AND STRUCTURES

**UNIT CODE: ENG/CU/WEF/CR/11/6/A**

**Relationship to Occupational Standards**

This unit of learning addresses the unit of competency: Fabricate products and structures

**Duration of Unit:**180 hours

**Unit Description**

This unit specifies competencies required for developing models and prototypes of products and structures, developing jigs and fixtures and planning production process.

**Summary of Learning Outcomes**

1. Lay out component
2. Produce components and products

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + - 1. Lay out component
 | * Observation of safety
* Factors to consider when selecting materials
* Types and application of;
	+ measuring and checking tools
	+ marking out tools
	+ cutting tools
	+ forming tools
	+ shaping tools
	+ rolling tools
* Identification of template materials
* Application of templates
 | * Observation
* Product checklist
* Oral questioning
* Written tests
 |
| * + - 1. Produce component and products
 | * Observation of safety
* Processes of;
	+ cutting
	+ forming
	+ shaping
	+ rolling
* Types and application of material joining processes
	+ Fasteners
	+ Welding
* Factors to consider in assembly of components
* Factors to consider in selecting finishing process
* Types of finishing process
* Deburring
* Polishing
* Painting
* Varnishing
* Oil blackening
* Bluing
* Buffing
* Electroplating
* Enameling
* Application of finishing processes
 | * Observation
* Product checklist
* Oral questioning
* Projects
 |

**Suggested Methods of Instruction**

* Trainer led facilitation of theory
* Demonstration of task by trainer
* Practice by trainee
* Industrial visits
* Viewing of videos of metal finishing processes

**Recommended Resources**

* Measuring and checking tools
* Marking out tools
* Forming tools
* Shaping tools
* Rolling tools
* Templates
* Cutting tools
* Finishing tools and equipment
* Video clips on electroplating and enameling