**A lion with two spears and a rooster

Description automatically generated**

**REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**CNC MILLING OPERATIONS (PRODUCTION)**

**KNQF LEVEL 4**

**PROGRAMME CODE: 0715 354A**

**© 2025**

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 …….., 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/Chief Principal at the address below:

**FOREWORD**

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

Reforms in the education sector are necessary to achieve Kenya Vision 2030 and meet the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution, and this resulted in the formulation of the Policy Framework for Reforming Education and Training in Kenya (Sessional Paper No. 14 of 2012). A key feature of this policy is the radical change in the design and delivery of 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 the mode of delivery allow for multiple entry and exit in TVET programmes.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that this curriculum has been developed. For trainees to build their skills on foundational hands-on activities of the occupation, units of learning are grouped in modules. This has eliminated duplication of content and streamlined exemptions based on skills acquired as a trainee progresses in the up-skilling process, while at the same time allowing trainees to be employable in the shortest time possible through the acquisition of part qualifications.

It is my conviction that this curriculum will play a great role in developing competent human resources for the Mechanical Engineering Production Sector’s growth and development.

**PRINCIPAL SECRETARY**

**STATE DEPARTMENT FOR TVET**

**MINISTRY OF EDUCATION**

**PREFACE**

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

TVET Act, CAP 210A and Sessional Paper No. 1 of 2019 on Reforming Education and Training in Kenya for Sustainable Development 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 the Kenyan labour force.

This curriculum has been developed in adherence to the Kenya National Qualifications Framework and CBETA standards and guidelines. The curriculum is designed and organized into Units of Learning with Learning Outcomes, suggested delivery methods, learning resources, and methods of assessing the trainee’s achievement. In addition, the units of learning have been grouped in modules to concretize the skills acquisition process and streamline upskilling.

I am grateful to all expert trainers and everyone who played a role in translating the Occupational Standards into this competency-based modular curriculum.

**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 were received from expert trainers, institutions and organizations.

I recognize with appreciation the role of the National Mechanical Production Engineering Sector Skills Committee (NSSC) in ensuring that competencies required by the industry are addressed in the curriculum. I also thank all stakeholders in the Mechanical Engineering Production sector for their valuable input and everyone who participated in developing this curriculum.

I am convinced that this curriculum will go a long way in ensuring that individuals aspiring to work in the Mechanical Engineering Production Sector acquire competencies to perform their work more efficiently and effectively.

TABLE OF CONTENTS

[FOREWORD iii](#_Toc197014724)

[ACKNOWLEDGEMENT v](#_Toc197014725)

[ABBREVIATIONS AND ACRONYMS vii](#_Toc197014726)

[KEY TO ISCED UNIT CODE viii](#_Toc197014727)

[COURSE OVERVIEW ix](#_Toc197014728)

[SUMMARY OF UNITS OF LEARNING ix](#_Toc197014729)

[MODULE I 1](#_Toc197014730)

[CAD DESIGN 2](#_Toc197014731)

[MODULE II 6](#_Toc197014732)

[CNC MILLING MACHINE PROGRAMMING 7](#_Toc197014733)

[CNC MILLING COMPONENTS PRODUCTION 13](#_Toc197014734)

# ABBREVIATIONS AND ACRONYMS

CBET Competency Based Education and Training

CAD Computer Aided Design

TVET Technical and Vocational Education and Training

2D Two dimensional

3D Three dimensional

CAM Computer aided manufacturing

CNC Computer numerical control

# KEY TO ISCED UNIT CODE

# COURSE OVERVIEW

CNC Milling Operations (production) level 4 consists of competencies that an individual must have to operate CNC Milling machine. It involves CAD design, CNC milling machine programming and CNC milling components production.

# SUMMARY OF UNITS OF LEARNING

|  |  |  |  |
| --- | --- | --- | --- |
| **CORE UNITS OF LEARNING** | | **HOURS** | **CREDIT FACTOR** |
| **MODULE I** | | | |
| 0715 351 01A | CAD Design | 300 | 30 |
| **MODULE II** | | | |
| 0715 351 02A | CNC Milling Machine Programming | 150 | 15 |
| 0715 351 03A | CNC Milling Components Production | 150 | 15 |
| **Industrial Training** | | **320** | **32** |
| **GRAND TOTAL** | | **920** | **92** |

**Entry Requirements**

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

1. Kenya Certificate of Secondary Education (KCSE)

**Or**

1. Equivalent qualifications as determined by TVETA

**Trainer qualifications**

Qualifications of a trainer for this course include:

1. Possession of at least level 5 qualification or its equivalent in related trade area; and
2. Licensed by TVETA
3. Registered by Engineer Board of Kenya (E.B.K) or Kenya Engineering Technology Registration Board (KETRB).

**Industry Training**

An individual enrolled in this course will be required to undergo Industry training for a minimum period of 320 hours in Mechanical Engineering Production sector. The industrial training may be taken after completion of all units for those pursuing the full qualification or be distributed equally in each unit for those pursuing part qualification. In the case of dual training model, industrial training shall be as guided by the dual training policy.

**Competence Assessment**

1. An individual enrolled in this course shall be assessed for competence through formative and summative assessments.
2. During formative assessment all performance criteria shall be assessed based on performance criteria weighting.
3. Number of formative assessments shall minimally be equal to the number of elements in a unit of competency.
4. During summative assessment basic and common units may be integrated in the core units or assessed as discrete units.
5. Theoretical and practical weighting for each unit of learning shall be as follows:
   1. 10:90 for the units in modules I and Module II
6. Formative and summative assessments shall be weighted at 60% and 40% respectively in the overall unit of learning score
7. For a candidate to be declared competent in a unit of competency, the candidate must meet the following conditions:
8. Obtained at least 40% in theory assessment in formative and summative assessments.
9. Obtained at least 60% in practical assessment in formative and summative assessment where applicable.
10. Obtained at least 50% in the weighted results between formative assessment and summative assessment where the former constitutes 60% and the latter 40% of the overall score.
11. Assessment performance rating for each unit of competency shall be as follows:

|  |  |
| --- | --- |
| **MARKS** | **COMPETENCE RATING** |
| 80 -100 | Attained Mastery |
| 65 - 79 | Proficient |
| 50 - 64 | Competent |
| 49 and below | Not Yet Competent |
| Y | Assessment Malpractice/irregularities |

1. Assessment for Recognition of Prior Learning (RPL) may lead to award of part and/or full qualification.

**Certification**

A candidate will be issued with a Certificate of Competency upon demonstration of competence in a core Unit of Competency. To be issued with KenyaNational TVET Certificate in CNC Milling Operations (Production) Level 4, the candidate must demonstrate competence in all the Units of Competency as given in the qualification pack. A Statement of Attainment certificate may be issued upon demonstration of competence in a certifiable element within a unit.

The certificates will be issued by the Qualification Awarding Institution

# MODULE I

## CAD DESIGN

**ISCED UNIT CODE:** 0732 351 01A

**Relationship to Occupational Standards**: Perform CAD Design

**Duration of Unit: 300 HOURS**

**Unit Description**

This unit covers the competencies required in performing CAD design. It involves developing conceptual design, generating engineering CAD drawings and manufacturing CAD design.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/NO.** | **learning outcome** | **duration (hours)** |
|  | Develop conceptual design | 80 |
|  | Generate engineering CAD drawings | 140 |
|  | Manufacture CAD design | 80 |
| **TOTAL** | | **300** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Develop conceptual design | * 1. Definition      1. Conceptual design      2. CAD   2. Conceptual design concepts      1. Sketching conceptual design concepts      2. Selecting conceptual design concepts | * Written tests * Practical * Project * Portfolio of Evidence |
| 1. Generate engineering CAD drawings | * 1. Introduction to engineering CAD software      1. AutoCAD      2. Inventor      3. Solidworks      4. Revit      5. ProSteel      6. X Steel   2. CAD Models      1. 2D CAD models      2. 3D CAD models   3. CAD Drawing Views      1. Orthographic views      2. Pictorial views   4. CAD drawing scales   5. CAD drawing dimensions and Tolerances   6. Creating basic shapes in CAD   7. Adding texts, notes and symbols in CAD   8. Editing and correcting errors in CAD   9. Saving and exporting an AutoCAD drawing | * Written tests * Practical * Project * Portfolio of Evidence |
| 1. Manufacture CAD design | * 1. Engineering CAM software      1. Definition         1. CAM         2. Engineering CAM software      2. Engineering CAM software         1. Autodesk fusion 360         2. Solid edge         3. Solidworks         4. Mastercam         5. Gibbs CAM         6. Feature CAM   2. Converting 3D CAD model into G and M Codes      1. G00      2. G01      3. G17      4. G18      5. G20      6. G54      7. G74      8. G90      9. M00      10. M01      11. M03      12. M04      13. M05      14. M30   3. Simulating G and M codes | * Written tests * Practical * Project * Portfolio of Evidence |

**Suggested Delivery Methods**

* Demonstration by trainer
* Discussions
* YouTube for teaching/learning and inspiration
* Simulation

**Recommended resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | For reference | 5 pcs | 1:5 |
|  | PowerPoint presentations | For trainer’s use | Adequate |  |
|  | Overhead projector |  | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/theory room | 12 by 10 Meters | 1 | 1:25 |
|  | Computer room/lab | 12 by 10 Meters | 1 | 1:25 |
| **C** | **Consumable Materials** | | | |
|  | Ream of printing papers | For printing | Adequate |  |
| **D** | **Tools and Equipment** | | | |
|  | CAD software | For programming | Adequate |  |
|  | CAM software | For programming | Adequate |  |

# MODULE II

# CNC MILLING MACHINE PROGRAMMING

**UNIT CODE:** 0715 351 02A

**Relationship to Occupational Standards**: Program CNC Milling Machine

**Duration of Unit: 150 HOURS**

**Unit Description**

This unit covers the competencies required to program a CNC milling machine. It involves preparing the lathe operation plan, preparing the CNC program and simulating the program.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/NO.** | **learning outcome** | **Duration (hours)** |
|  | Prepare milling operation plan | 30 |
|  | Prepare CNC milling program | 100 |
|  | Simulate program | 20 |
| **TOTAL** | | **150** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Prepare milling operation plan | * 1. Machine referencing   2. Tool setup      1. Tool mounting      2. Tool holding      3. Tool offset      4. Tool wear compensation   3. Pre-operation inspections      1. Coolant, oil, and hydraulic oil levels   4. Clamping devices setup      1. Pneumatic chuck      2. Conventional chuck      3. Collets      4. Faceplate      5. Steady rests   5. Machining parameters      1. Cutting speed      2. Feed rate      3. Depth of cut      4. Tool nose radius      5. Tool offset      6. Spindle speed      7. Coolant flow rate   6. Coordinate system setup   7. Workpiece setup | * Written tests * Practical * Project * Portfolio of Evidence |
| 1. Prepare CNC milling program | * 1. Tool path geometry and machine function      1. Describe CNC lathe machine tool path geometry   2. Generating CNC lathe machine G and M Codes      1. G00      2. G01      3. G17      4. G18      5. G20      6. G54      7. G74      8. G90      9. M00      10. M01      11. M03      12. M04      13. M05      14. M30   3. Editing G and M Codes |  |
| 1. Simulate program | * 1. Simulating machine operations      1. Plain milling      2. Straddle milling      3. Gang milling      4. Gear cutting      5. Face milling      6. Side milling      7. Drilling      8. Boring   2. Trial runs      1. Testing machine operation      2. Inspecting the quality of finished work   3. Checking and editing errors | * Written tests * Practical * Project * Portfolio of Evidence |

**Suggested Delivery Methods**

* Demonstration by trainer
* Discussions
* YouTube for teaching/learning and inspiration
* Simulation

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | For reference | 5 | 1:5 |
|  | PowerPoint presentations | For trainer’s use | Adequate |  |
|  | Overhead projector | For display | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/theory room | 12 by 10 Meters | 1 | 1:25 |
|  | Workshop | 20 by 15 Meters | 1 | 1:25 |
|  | Work benches | For bench work operations | 8 | 1:4 |
| **C** | **Consumable Materials** | | | |
|  | First aid kit | For first aid | 1 | 1:25 |
|  | Ream of printing papers | For printing | Adequate |  |
|  | Cleaning detergents | For cleaning | Adequate |  |
|  | Cotton wool waste | For cleaning | Adequate |  |
| D | **Raw Material** | | | |
|  | Aluminum round and flat bar | Workpiece material | Adequate |  |
|  | Mild steel round and flat bar | Workpiece material | Adequate |  |
|  | Brass flat and round bar | Workpiece material | Adequate |  |
| **E** | **Tools and Equipment** | | | |
|  | Hacksaws | For Material cutting | 25 pcs | 1:1 |
|  | Measuring tools | For measurement | 25 pcs | 1:1 |
|  | Marking out tools | For marking out | 25 pcs | 1:1 |
|  | Cutting tools | For cutting material | 5 pcs | 1:5 |
|  | CNC milling machines | For milling operation | 3 pcs | 1:8 |
|  | Pedestal grinding machine | For grinding | 1 pcs | 1:25 |
|  | Bench vices | For work holding | 25 pcs | 1:1 |
|  | File card | For file cleaning | 25 pcs | 1:1 |
|  | Firefighting equipment | For fire fighting | 1 pcs | 1:25 |
|  | CAD software | For programming | 1 | 1:25 |
|  | CAM software | For programming | 1 | 1:25 |
| F | **Milling Accessories** | | | |
|  | Vices | For work holding | 5 | 1:5 |
|  | Rotary Table | For work holding | 3 | 3:25 |
|  | Clamping kits | For work clamping | 3 | 3:25 |
|  | End mill holders | For tool holding | 3 | 3:25 |
|  | Drill chuck and arbor | For tool holding | 3 | 3:25 |
|  | Keyless drill chuck | For tool holding | 3 | 3:25 |
|  | Tape measure | For measurement | 5 pcs | 1:5 |
| G | **Assorted Milling Tools** | | | |
|  | End Mills | For material removal | 3 | 3:25 |
|  | Face Mills | For material removal | 3 | 3:25 |
|  | Fly Cutters | For material removal | 3 | 3:25 |
|  | Slab Mills | For material removal | 3 | 3:25 |
|  | Slot Drills | For material removal | 3 | 3:25 |
|  | Thread mills | For material removal | 3 | 3:25 |
|  | Form milling cutters | For material removal | 3 | 3:25 |
|  | T-Slot cutters | For material removal | 3 | 3:25 |

## CNC MILLING COMPONENTS PRODUCTION

**ISCED UNIT CODE:** 0715 351 03A

**Relationship to Occupational Standards:** Produce CNC milling Components

**Duration of Unit: 150 HOURS**

**Unit Description**

This unit covers the competencies required to produce CNC components. It involves setting up CNC lathe machines, uploading generated CNC programs and performing CNC lathe operations.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/NO.** | **learning outcome** | **Duration (hours)** |
|  | Set up CNC milling machine | 80 |
|  | Upload generated CNC programs | 20 |
|  | Perform CNC milling operations | 50 |
| **TOTAL** | | **150** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Set up CNC milling machine | * 1. Safety      1. Workshop rules and regulations      2. Personal protective equipment (PPE)      3. Machine safety   2. CNC milling machine referencing      1. Machine zero      2. Work zero      3. Workpiece offsets   3. CNC milling machine tools      1. Face cutter      2. Involute gear cutter      3. End milling cutter      4. Angular cutter      5. Side cutter      6. T slot cutter      7. Slab cutter   4. CNC milling machine tool setup      1. Tool mounting      2. Tool holding      3. Tool offset   5. CNC machine workpiece setup      1. Work mounting   6. CNC milling machine parameters      1. Tool offset      2. Feed rate      3. Speed      4. Workpiece offset      5. Cutting depth | * Written tests * Practical * Project * Portfolio of Evidence |
| 1. Upload generated CNC programs | * 1. Input CNC programme      1. CAD      2. CAM      3. G and M   2. Inputting CNC program into the CAM interface   3. Simulation of CNC programs | * Written tests * Practical * Project * Portfolio of Evidence |
| 1. Perform CNC milling operations | * 1. CNC milling operations      1. Roughing      2. Facing      3. Turning      4. Grooving      5. Threading      6. Drilling      7. Boring   2. Monitoring CNC operations      1. Tool movement      2. Tool change      3. Feed rate      4. Cutting speed      5. Spindle speed      6. Depth of cut   3. Inspection of finished product      1. Dimensions      2. Surface Finish      3. Functionality   4. Preventive maintenance      1. Cleaning      2. Lubrication      3. Minor repairs of tools      4. Housekeeping | * Written tests * Practical * Project * Portfolio of Evidence |

**Suggested Delivery Methods**

* Demonstration
* Discussions
* Industrials visits
* YouTube for teaching/learning and inspiration.

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | For reference | 5 pcs | 1:5 |
|  | PowerPoint presentations | For trainer’s use | Adequate |  |
|  | Overhead projector | For display | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/theory room | 12 by 10 Meters | 1 | 1:25 |
|  | Workshop | 20 by 15 Meters | 1 | 1:25 |
|  | Work benches | For bench work operations | 8 | 8:25 |
| **C** | **Consumable Materials** | | | |
|  | First aid kit | For first aid | 1 | 1:25 |
|  | Ream of printing papers | For printing | Adequate |  |
|  | Cleaning detergents | For cleaning | Adequate |  |
|  | Cotton wool waste | For cleaning | Adequate |  |
| D | **Raw Material** | | | |
|  | Aluminum flat and round bar | For workpiece material | Adequate |  |
|  | Mild steel flat and round bar | For workpiece material | Adequate |  |
|  | Brass flat and round bar | For workpiece material | Adequate |  |
|  | Plates | For workpiece material | Adequate |  |
| **E** | **Tools and Equipment** | | | |
|  | Hacksaws | For Material cutting | 25 pcs | 1:1 |
|  | Measuring tools | For measurement | 25 pcs | 1:1 |
|  | Marking out tools | For marking out | 25 pcs | 1:1 |
|  | Cutting tools | For cutting material | 5 pcs | 1:5 |
|  | CNC milling machines | For milling operation | 3 pcs | 3:25 |
|  | Pedestal grinding machine | For grinding | 1 pcs | 1:25 |
|  | Bench vices | For work holding | 25 pcs | 1:1 |
|  | File card | For file cleaning | 25 pcs | 1:1 |
|  | Firefighting equipment | For fire fighting | 1 pcs | 1:25 |
|  | CAD software | For programming | 1 | 1:25 |
|  | CAM software | For programming | 1 | 1:25 |
|  | **Milling Accessories** | | | |
|  | Vices | For work holding | 5 pcs | 1:5 |
|  | Rotary Table | For work holding | 3 pcs | 3:25 |
|  | Clamping kits | For work clamping | 5 pcs | 1:5 |
|  | End Mill Holders | For tool holding | 5 pcs | 1:5 |
|  | Drill Chuck and Arbor | For tool holding | 5 pcs | 1:5 |
|  | Keyless Drill Chuck | For tool holding | 5 pcs | 1:5 |
|  | Tape measure | For measurement | 5 pcs | 1:5 |
|  | **Assorted Milling Tools** | | | |
|  | End Mills | For material removal | 3 | 3:25 |
|  | Face Mills | For material removal | 3 | 3:25 |
|  | Fly Cutters | For material removal | 3 | 3:25 |
|  | Slab Mills | For material removal | 3 | 3:25 |
|  | Slot Drills | For material removal | 3 | 3:25 |
|  | Thread mills | For material removal | 3 | 3:25 |
|  | Form milling cutters | For material removal | 3 | 3:25 |
|  | T-Slot cutters | For material removal | 3 | 3:25 |
|  | Inserts | For material removal | 3 | 3:25 |