

**REPUBLIC OF KENYA**

**NATIONAL OCCUPATIONAL STANDARDS**

**FOR**

**CNC MILLING OPERATOR (PRODUCTION)**

**KNQF LEVEL 4**

**PROGRAMME CODE: 0715354A**

# 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, Vision 2030 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 of Kenya 2010 and this resulted in 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 institutions be competency based, curriculum development be industry led, certification be based on demonstration of competence and mode of delivery to allow for multiple entry and exit in TVET programmes. These reforms demand that industry takes a leading role in occupational standards development to ensure it addresses competence needs.

It is against this background that these Occupational Standards have been developed for a competency-based mechanical production standard. These Occupational Standards will also be the basis for assessment of an individual for competence certification.

It is my conviction that these Occupational Standards will play a key role towards development of competent human resource for the engineering sector’s growth and development.

# 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 (TVET) 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 in order 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.

Incumbent mechanical engineering industry experts in conjunction with expert subject trainers and other related stakeholders have developed these Occupational Standards for CNC Milling Operator level 4. These standards will be the basis for development of competency-based curriculum for CNC Milling Operator Level 4.

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

I am grateful to everyone who participated in the development of these Occupational Standards.

# ACRONYMNS

CBET Competency Based Education and Training

CAD Computer Aided Design

TVET Technical and Vocational Education and Training

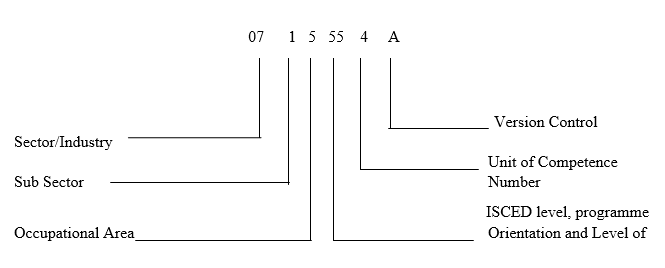
2D Two dimensional

3D Three dimensional

CAM Computer aided manufacturing

CNC computer numerical control

# KEY TO UNIT CODE



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# OVERVIEW

This document contains occupational standards designed to prescribe competences required for the qualification of CNC Milling operator Level 4. These competences are required in order to perform CAD design, program CNC milling and produce CNC components.

The course consists of core units of competency as indicated hereafter:

**SUMMARY OF UNITS OF COMPETENCY**

|  |  |
| --- | --- |
| **UNIT CODE** | **UNIT TITLE** |
| 0732 351 01A | Perform CAD Design |
| 0715 351 02A | Program CNC Milling Machines |
| 0715 351 03A | Produce CNC Milling Components |

# CORE UNITS OF LEARNING

## PERFORM CAD DESIGN

**UNIT CODE:** 0732 351 01A

**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

**ELEMENT AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms*** ***are elaborated in the Range*** |
| Develop conceptual design | * 1. Conceptual design need is defined according to job requirements.   2. Conceptual design brainstorming is carried out as per job requirement.   3. Conceptual design concepts are sketched according to design requirement.   4. Conceptual design concept is selected as per job description. |
| Generate engineering CAD drawings | * 1. ***Engineering CAD software*** is selected according to design requirement.   2. 2D or 3D CAD models are created according to design concept.   3. CAD drawing views are determined as per the drawing standards.   4. CAD drawing scale is determined as per the drawing standards.   5. CAD drawing dimensions and tolerances are determined as per the drawing standards   6. Basic shapes are created as per the software specifications.   7. Details and features are added as per software specifications.   8. CAD drawing errors are checked and corrected according to design specifications.   9. Engineering CAD drawing is saved and exported according to CAD software specification. |
| 3. Manufacture CAD design | * 1. ***Engineering CAM software*** is selected as per design requirements.   2. 3D CAD model is converted into ***G and M code*** as per the software specifications.   3. ***G and M code*** is simulated as per the software requirement. |

**RANGE**

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

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Engineering CAD software | Include but not limited to:   * AutoCAD * Inventor * Solidworks * Revit * ProSteel * X Steel |
| 1. Engineering CAM software | Include but not limited to:   * Autodesk Fusion 360 * Solid Edge * SolidWorks * Mastercam * GibbsCAM * FeatureCAM |
| 1. G and M code | Include but not limited to:   * G00 * G01 * G17 * G18 * G20 * G54 * G74 * G90 * M00 * M01 * M03 * M04 * M05 * M30 |

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required Skills**

The individual needs to demonstrate the following skills:

* Problem solving
* Communication skills
* Technical drawing
* Measurements
* Digital literacy
* Brainstorming skills
* Understanding of design principles
* Attention to detail

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* CAD software proficiency
* Preparing engineering drawings
* Basic Mathematics
* Geometry
* Dimensions and tolerancing

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| * + - 1. Critical aspects of Competency | Assessment requires evidence that the candidate:   * 1. Defined conceptual design need according to job requirements.   2. Selected conceptual design concept as per job description.   3. Selected Engineering CAD software according to design requirement.   4. Created 2D or 3D CAD models according to design concept.   5. Determined CAD drawing dimensions and tolerances as per the drawing standards   6. Added details and features as per software specifications.   7. Selected Engineering CAM software as per design requirements.   8. Converted 3D CAD model into G and M code as per the software specifications. |
| * + - 1. Resource Implications | The following resources should be provided:   * 1. A workshop equipped with:      1. Computer      2. CAD Software      3. CAM Software |
| * + - 1. Methods of Assessment | * 1. Written assessment   2. Oral questioning/interview   3. Observation   4. Simulation   5. Third party   6. Project |
| * + - 1. Context of Assessment | * 1. On-job   2. Simulated workplace environment |
| * + - 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## PROGRAM CNC MILLING MACHINE

**UNIT CODE:** 0715 351 02A

**UNIT DESCRIPTION**

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

**ELEMENT AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms*** ***are elaborated in the Range*** |
| Prepare milling operation plan | * 1. Tool path geometry and machine function are identified as per the working drawing.   2. ***Machining parameters*** are determined as per work specifications.   3. Coordinate system is set as per working sequence. |
| Prepare CNC milling program | * 1. Tool paths are generated as per working drawing specifications.   2. ***G and M codes*** are generated as per the working drawing.   3. G and M codes are edited as per requirement. |
| Simulate program | * 1. ***Machining operations*** are simulated for accuracy as per work specifications.   2. Trial runs are conducted to check machine operation and quality of finished work as per operation manual.   3. Errors are checked and rectified according to simulation. |

**RANGE**

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

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Machining parameters | Include but not limited to:   * Cutting speed * Feed rate * Depth of cut * Tool nose radius * Tool offset * Spindle speed * Coolant flow rate |
| 1. G and M code | Include but not limited to:   * G00 * G01 * G17 * G18 * G20 * G54 * G74 * G90 * M00 * M01 * M03 * M04 * M05 * M30 |
| 1. Machining operations | Include but not limited to:   * Plain milling * Straddle milling * Gang milling * Gear cutting * Face milling * Side milling * Drilling * Boring |

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required Skills**

The individual needs to demonstrate the following skills:

* Problem solving
* Communication skills
* Technical drawing
* Measurements
* Digital literacy
* Attention to detail

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* CAD software proficiency
* Preparing engineering drawings
* Basic Mathematics
* Geometry
* Dimensions and tolerances

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| * + - 1. Critical aspects of Competency | Assessment requires evidence that the candidate:   * 1. Identified tool path geometry and machine function as per the working drawing.   2. Determined machining parameters as per work specifications.   3. Set coordinate system as per working sequence.   4. Generated G and M codes as per the working drawing.   5. Simulated machining sequences for accuracy as per work specifications. |
| * + - 1. Resource Implications | The following resources should be provided:   * 1. A workshop equipped with:      1. Computer      2. CAD Software      3. CAM Software      4. CNC milling machine |
| * + - 1. Methods of Assessment | * 1. Written assessment   2. Oral questioning/interview   3. Observation   4. Simulations   5. Practical   6. Third party |
| * + - 1. Context of Assessment | * 1. On-job   2. Simulated workplace environment |
| * + - 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## PRODUCE CNC MILLING COMPONENTS

**UNIT CODE:** 0715 351 03A

**UNIT DESCRIPTION**

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

**ELEMENT AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms*** ***are elaborated in the Range*** |
| Set up CNC milling machine | * 1. Health and safety procedures are applied as per health and safety standards.   2. CNC milling machine is referenced as per work requirement.   3. ***CNC milling machine tools*** are set up as per work requirement.   4. CNC milling machine work is set up as per work requirement.   5. ***CNC milling machine parameters*** are set up as per machine specifications. |
| Upload generated CNC programs | * 1. Program to be executed is selected as per work requirement.   2. ***CNC program*** is inputted into the CAM interface as per work requirement.   3. CNC program is simulated as per work requirement. |
| Perform CNC milling operations | * 1. CNC ***milling operation*** execution is carried out as per work requirement.   2. CNC milling operations are monitored as per job requirement.   3. Finished work is inspected as per job requirement.   4. Preventive maintenance is carried out as per machine specifications. |

**RANGE**

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

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. CNC milling machine tools | Include but not limited to:   * Face cutter * Involute gear cutter * End milling cutter * Angular cutter * Side cutter * T slot cutter * Slab cutter |
| 1. CNC milling machine parameters | Include but not limited to:   * Tool offset * Feed rate * Speed * Work offset * Referencing |
| 1. CNC program | Include but not limited to:   * CAD * CAM * G and M |
| 1. CNC milling operation | Include but not limited to:   * Plain milling * Straddle milling * Gang milling * Gear cutting * Face milling * Side milling * Drilling * Boring |
| 1. Preventive maintenance | * Cleaning * Lubrication * Housekeeping * Minor repairs of tools |

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required Skills**

The individual needs to demonstrate the following skills:

* Problem solving
* Communication skills
* Technical drawing
* Measurements
* Digital literacy
* Attention to detail

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* CAD software proficiency
* Preparing engineering drawings
* Basic Mathematics
* Geometry
* Dimensions and tolerances

**EVIDENCE GUIDE**

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

|  |  |
| --- | --- |
| * + - 1. Critical aspects of Competency | Assessment requires evidence that the candidate:   * 1. Applied health and safety procedures as per health and safety standards.   2. Referenced CNC milling machine as per work requirement.   3. Set up CNC milling machine tools as per work requirement.   4. Set up CNC milling machine work as per work requirement.   5. Set up CNC milling machine parameters as per machine specifications.   6. Selected program to be executed as per work requirement.   7. Inputted CNC program into the CAM interface as per work requirement.   8. Carried out CNC milling operation as per work requirement.   9. Monitored CNC milling operations as per job requirement. |
| * + - 1. Resource Implications | The following resources should be provided:   * 1. A workshop equipped with:      1. Computer      2. CAD Software      3. CAM Software      4. CNC milling machine |
| * + - 1. Methods of Assessment | * 1. Written assessment   2. Oral questioning/interview   3. Observation   4. Simulations   5. Practical   6. Third party |
| * + - 1. Context of Assessment | * 1. On-job   2. Simulated workplace environment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |