**A lion with two spears and a rooster

Description automatically generated**

**REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**CNC LATHE OPERATIONS (PRODUCTION)**

**KNQF LEVEL 4**

**PROGRAMME CODE: 0715 354A**

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**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 Engineering Production 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 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.

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# 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 Lathe Operations level 4 consists of competencies that an individual must have to operate CNC Lathe machine. It involves CAD Design, CNC lathe machine programming and CNC lathe components production.

**SUMMARY OF UNITS OF LEARNING**

|  |  |  |  |
| --- | --- | --- | --- |
| **CORE UNITS OF LEARNING** | | **HOURS** | **CREDIT FACTOR** |
| **MODULE I** | | | |
| 0715 351 06A | CAD DESIGN | 300 | 30 |
| **MODULE II** | | | |
| 0715 351 07A | CNC LATHE MACHINE PROGRAMMING | 200 | 20 |
| 0715 351 08A | CNC LATHE COMPONENTS | 100 | 10 |
| **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 Technical Vocational and Education and Training Authority (TVETA)

**Trainer qualification**

A trainer for this course must:

1. Have a minimum of KNQF Level 5 qualification mechanical production technician or its equivalent in a related trade area.
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 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 Lathe Operations 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:** 0715 351 06A

**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**

By the end of this unit, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| 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 Tests * Projects * Portfolio of Evidence |
| 1. Generate engineering CAD drawings | * 1. 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 Tests * Projects * Portfolio of Evidence |
| 1. Manufacture CAD design | * 1. Engineering CAM ssoftware      1. Definition         1. CAM         2. Engineering CAM ssoftware      2. Engineering CAM ssoftware         1. Autodesk fusion 360         2. Solid edge         3. SolidWorks         4. Mastercam         5. GibbsCAM         6. FeatureCAM   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 Code | * Written tests * Practical Tests * Projects * Portfolio of Evidence |

**Suggested Delivery Methods**

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

**List of Recommended Resources (For 25 Trainees)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning materials** | | | |
|  | Textbooks | Reference | 5 pcs | 1:5 |
|  | PowerPoint presentations | For trainer’s use |  |  |
|  | Overhead projector | Display | 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 | Adequate | Adequate |  |
| **D** | **Tools and equipment** | | | |
|  | CAD software | For Design | 1 | 1:25 |
|  | CAM software | For Design | 1 | 1:25 |

# MODULE II

## CNC LATHE MACHINE PROGRAMMING

**ISCED UNIT CODE:** 0715 351 07A

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

**Duration of Unit: 200 HOURS**

**Unit Description**

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

**Summary of Learning Outcomes**

By the end of this unit, trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcome** | **Duration (Hours)** |
|  | Prepare lathe operation plan | **20** |
|  | Prepare CNC lathe program | **160** |
|  | Simulate program | **20** |
| **TOTAL** | | **200** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Prepare lathe operation plan | * 1. Introduction      1. Define operation plans      2. How to prepare operation plans      3. Significance of lathe operation plans   2. Machine referencing      1. Machine zero      2. Work zero      3. Work offsets   3. CNC Lathe Machine Tool Setup      1. Tool mounting      2. Tool holding      3. Tool offset      4. Tool wear compensation   4. Pre-operation Inspections      1. Coolant, oil, and hydraulic levels   5. Clamping devices setup      1. Pneumatic chuck      2. Conventional chuck      3. Collets      4. Faceplate      5. Steady rests   6. 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   7. Coordinate System Setup   8. Workpiece Setup | * Written tests * Practical Tests * Projects * Portfolio of Evidence |
| 1. Prepare CNC lathe 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 | * Written tests * Practical Tests * Projects * Portfolio of Evidence |
| 1. Simulate program | * 1. Simulating machine sequences      1. Roughing      2. Facing      3. Turning      4. Grooving      5. Threading      6. Drilling      7. Boring   2. Trial Runs      1. Testing machine operation      2. Inspecting the quality of finished work   3. Checking and editing errors | * Written tests * Practical Tests * Projects * 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 | 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 | 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 materials** | | | |
|  | Aluminum round bar | For workpiece material | Adequate |  |
|  | Mild steel round bar | For workpiece material | Adequate |  |
|  | Brass round bar | For workpiece material | Adequate |  |
|  | PVC round bar | For workpiece material | Adequate |  |
| **D** | **Tools and Equipment** | | | |
|  | Hacksaws | Metal cutting | 25 pcs | 1:1 |
|  | Measuring tools | Measurement | 5pcs | 1:5 |
|  | Marking out tools | Marking out | 5 pcs | 1:5 |
|  | Cutting tools | Cutting | 5 pcs | 1:5 |
|  | CNC lathe machines | Machining | 5 pcs | 1:5 |
|  | Pedestal grinding machine | Grinding | 1 pcs | 1:25 |
|  | Bench vices | Work holding | 25 pcs | 1:1 |
|  | File card | File cleaning | 5pcs | 1:5 |
|  | Firefighting equipment | Fire fighting | 1 pcs | 1:25 |
|  | CAD software | For Programming | 1 | 1:25 |
|  | CAM software | For Programming | 1 | 1:25 |
| E | **Lathe Accessories** | | | |
|  | Chucks | For Work holding | 3 | 1:8 |
|  | Lathe centre | For Workpiece support | 3 | 1:8 |
|  | Lathe mandrel | For Work support | 3 | 1:8 |
|  | Rest | For work support | 3 | 1:8 |
|  | Jigs and fixtures | For tool, work holding and tool guiding | 3 | 1:8 |
|  | Tape measure | For Measurement | 25 pcs | 1:1 |
| **F** | **Assorted lathe tools** | | | |
|  | Turning tool | For Cutting | 5 pcs | 1:5 |
|  | Facing tool | For Cutting | 5 pcs | 1:5 |
|  | Chauffeuring tool | For Cutting | 5 pcs | 1:5 |
|  | Form tool | For Cutting | 5 pcs | 1:5 |
|  | Parting tool | For Cutting | 5 pcs | 1:5 |
|  | External threading tool | For Cutting | 5 pcs | 1:5 |
|  | Internal threading tool | For Cutting | 5 pcs | 1:5 |
|  | Boring tool | For Cutting | 5 pcs | 1:5 |
|  | Knurling tool | For Cutting | 5 pcs | 1:5 |

## CNC LATHE COMPONENTS PRODUCTION

**ISCED UNIT CODE:** 0715 351 08A

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

**Duration of Unit: 100 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**

By the end of this unit, trainee should be able to:

|  |  |  |
| --- | --- | --- |
| **Unit Code** | **Unit Title** | **Unit Duration (Hours)** |
|  | Set up CNC lathe machine | **20** |
|  | Upload generated CNC programs | **20** |
|  | Perform CNC lathe operations | **60** |
| **TOTAL** | | **100** |

**Learning outcomes, content and suggested assessment methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Set up CNC lathe machine | * 1. Health and safety procedures      1. Workshop rules and regulations      2. Personal protective equipment (PPE)      3. Machine safety   2. CNC lathe machine referencing   3. CNC lathe machine tools      1. Turning tool      2. Facing tool      3. Boring tool      4. Drilling bits      5. Threading tool      6. Slotting tool      7. Knurling tool   4. CNC lathe machine tool setup      1. Tool mounting      2. Tool holding      3. Tool offset   5. CNC lathe machine workpiece setup      1. Work mounting   6. CNC lathe machine parameters      1. Tool offset      2. Feed rate      3. Speed      4. Work offset      5. Referencing | * Written Test * Practical Tests * Projects * Portfolio of Evidence |
| 1. Upload generated CNC programs | * 1. CNC pprograms      1. Examples of CNC pprograms         1. CAD         2. CAM         3. G and M   2. Inputting CNC program into the CAM interface   3. Simulation of CNC Programs | * Written Test * Practical Tests * Projects * Portfolio of Evidence |
| 1. Perform CNC lathe operations | * 1. CNC lathe ooperations      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. Safe removal of finished pproduct   4. Inspection of ffinished pproduct   5. Preventive mmaintenance      1. Lubrication      2. Troubleshooting | * Written Test * Practical Tests * Projects * Portfolio of Evidence |

**Suggested Delivery Methods**

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

**List of recommended resources**

**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 |
|  | Charts | For Reference | Adequate |  |
|  | PowerPoint presentations | For trainer’s use | Adequate |  |
|  | Overhead projector | For Display | 1 | 1:25 |
| **B** | **Learning facilities & infrastructure** | | | |
|  | Lecture/theory room | For practical | 1 | 1:25 |
|  | Workshop | For practical | 1 | 1:25 |
|  | Work benches | For practical | 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 |  |
|  | Grinding paste | For grinding | Adequate |  |
|  | Aluminum round bar | For workpiece material | Adequate |  |
|  | Mild steel round bar | For workpiece material | Adequate |  |
|  | Brass round bar | For workpiece material | Adequate |  |
|  | PVC round bar | For workpiece material | Adequate |  |
| **D** | **Tools and equipment** | | | |
|  | Hacksaws | For Cutting | 25 pcs | 1:1 |
|  | Assorted measuring tools | For measurement | 25 pcs | 1:1 |
|  | Assorted marking out tools | For marking out | 25 pcs | 1:1 |
|  | Assorted cutting tools | For cutting | 5 pcs | 1:5 |
|  | CNC lathe machines | For Machining | 3pcs | 3:25 |
|  | Pedestal grinding machine | For grinding | 1 pcs | 1:25 |
|  | Bench vices | For bench operations | 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 |
| **E** | **Lathe accessories** | | | |
|  | Chucks | For work holding | 3 | 3:25 |
|  | Lathe centre | For work centering | 3 | 3:25 |
|  | Lathe mandrel | For work holding | 3 | 3:25 |
|  | Rest | For work supporting | 3 | 3:25 |
|  | Jigs and fixtures | Tool, work holding and tool guiding | 3 | 3:25 |
|  | Tape measure | For measurement | 25 pcs | 1:1 |
| **F** | **Assorted lathe tools** | | | |
|  | Turning tool | For Cutting | 5 pcs | 1:5 |
|  | Facing tool | For Cutting | 5 pcs | 1:5 |
|  | Chauffeuring tool | For Cutting | 5 pcs | 1:5 |
|  | Form tool | For Cutting | 5 pcs | 1:5 |
|  | Parting tool | For Cutting | 5 pcs | 1:5 |
|  | External threading tool | For Cutting | 5 pcs | 1:5 |
|  | Internal threading tool | For Cutting | 5 pcs | 1:5 |
|  | Boring tool | For Cutting | 5 pcs | 1:5 |
|  | Knurling tool | For Cutting | 5 pcs | 1:5 |