Skills for Employment Investment Program (SEIP)

COMPETENCY-BASED LEARNING MATERIAL

(FACULTY GUIDE)

FOR

CNC MACHINE OPERATION

(LIGHT ENGINEERING SECTOR)

Finance Division, Ministry of Finance
Government of the People's Republic of Bangladesh

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Approval Sheet

Identification and validation of modules and content for this occupation were made by experts within this sector. A series of consultations were held to accurately capture industry and employer needs and expectations and develop the learning material that would help to enhance the employability of the youth trained. This process started on 26 August 2018 and concluded with a validation workshop with a sectoral working group on 25 October 2018.

Experts Involved

Industry and subject-matter experts who provided their valuable inputs to develop this competency-based learning material [August 2018 – October 2018]:

Name	Organisation	Designation
Md. Farque Ahmed	BCSIR	Engineer
Md. Masud Rana	BITAC	Executive Engineer
Uttam Kumar Das	BKTTC (Chittagong)	Instructor
Mozammel Mia	AUST	Assistant Professor
David King	British Council - SD03	Team Leader
Dr. Nikhil Dhar	British Council - SD03	National Subject Matter Consultant - Light Engineering Sector

Validation Workshop

Competency-based learning material validation workshop participants [held on 25 October 2018]:

Name	Organisation	Designation
Md. Farque Ahmed	BCSIR	Engineer
Md. Masud Rana	BITAC	Executive Engineer
Uttam Kumar Das	BKTTC (Chittagong)	Instructor
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Rupak Kanti Biswas	BTEB	Quality Assurance Officer
Md. Abdur Razzaque	SEIP-BTEB	Specialist-1 (Competency Standards)
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Mr Mohiuzzaman	SEIP	Course Specialist
Dr. Nikhil Dhar	British Council - SD03	National Subject Matter Consultant - Light Engineering Sector

Committee Workshop

The National competency-based learning material for National Skills Certificate in CNC Machine Operation**, NTVQF Level [INSERT LEVEL]** qualification is a document developed by the Skill for Employment Investment Programme (SEIP), Finance Division, Ministry of Finance. This competency-based learning material has been developed by an industry expert group under guidance of SEIP. The competency-based learning material was approved by the SCDC [BTEB to insert date] at NTVQF Cell, BTEB.

Respectable members of the SCDC:

CNC Machine Operation - Level [INSERT LEVEL]		

How to Use this Competency-based Learning Material

Welcome to the competency-based learning material for CNC Machine Operation to use in light engineering works. These modules contain training materials and activities for learners to complete in order to become competent and qualified as a skilled worker.

There are six (6) modules that make up this course which comprises the skills, knowledge and attitudes required to become a skilled worker including:

1. Perform basic lathe machine operations
2. Perform basic milling operations
3. Carry out CNC lathe machine operations
4. Carry out CNC milling machine operations
5. Carry out CNC wire cut machine operations
6. Apply knowledge of CAM

As a trainer, you are required to guide the learners through a series of activities in order to complete each learning outcome of the module. These activities may be completed as part of structured classroom activities or they may be required to work at their own pace.

These activities will require the learners to complete associated learning and practice activities in order to gain knowledge and skills they need to achieve the learning outcomes. Refer to **Learning Activity Page of each module** to know the sequence of learning tasks and the appropriate resources to use for each task.

This page will serve as the road map towards the achievement of competence. If you read the **Information Sheets,** these will give you an understanding of the work, and why things are done the way they are. Once the learners have finished reading the Information Sheets, they are required to complete the questions in the **Self-Check Sheets**.

The self-check process follows the Information Sheets in the learning guide. Completing self-checks will help the learners know how they are progressing. To know how they fared with self-checks, they can review the **Answer Key**.

The learners are required to complete all activities as directed in the **Job Sheet**. This is where they will apply their newly acquired knowledge while developing new skills. When working, high emphasis should be laid on safety requirements. The learners should be encouraged to raise relevant queries or ask the facilitator for assistance as required.

When the learners have completed all the tasks required in the learning guide, an assessment event will be scheduled to evaluate if they have achieved competency of the specified learning outcomes and are ready for the next task.

Introduction to Teaching Adult Learners

Since you will be dealing with adult learners, it is important to understand the basic principles of adult learning and methodologies. Adults learn best through associations, experiences and application. A few facts to consider while teaching adult learners:

Discussion: Adult learning is best managed through mutual dialogue and discussion. Discussion needs to be encouraged and used in the classroom to maximise learning.

Associations: Adults have experiences which can be related to any learning objectives to create associations which enhance conceptual comprehension. Associations can be used to create user interest and gain attention. Adults learn new attitudes or skills best in relation to previous life experiences.

This strategy also ensures knowledge retention.

Create an environment conducive to learning and sharing: Make people feel comfortable talking to you and each other. They should feel at ease asking questions, sharing views even if they are not very sure of the efficacy of their suggestions or views.

Physical surroundings: Temperature, light, space and furniture should be optimal. There should be no distractions.

Inculcate respect: Encourage learners' contributions and experiences. People are more encouraged to learn and share when their experiences are acknowledged - new information builds easily on past knowledge and experience.

Reward and recognition: Acknowledging the efforts of people, even small attempts, can reap great benefits. Learners like to receive praise and positive encouragement, which motivates them to deliver their best.

Learners also like to be reassured that they are correctly recalling or using information they have absorbed in the classroom.

Structured teaching: Learners study faster when information or skills are presented in a structured way**:**

- Concepts to be taught in small, bite sized portions for easy assimilation
- Put forth the easiest ideas or skills first and then gradually build on them
- Bring in the important ideas first
- Reinforce key ideas at regular intervals
- Reinforce high order concepts at regular intervals

Move learner from generic to specific flow of information: Introduce the generic concepts first and then move to specific more complex information to ease understanding and comprehension.

Application of concepts/ideas taught: Help students put into practice the concepts taught in the class through exercises and work-based projects. Application ensures knowledge retention and skill building.

Relevance building: Build up relevance of the concepts being taught in class by relating them to day-to-day life and workplace experiences.

Learners should know to use and apply what they have learned in the classroom as they learn faster when they recognise that what they are learning will be useful in the future.

Sharing: Encourage learners to learn from each other and solve problems collectively. This makes learning easier and improves team spirit and the interpersonal skills of the learners.

Participation: Involve learners in the class - adults favour to be *active participants* in learning rather than passive receivers of knowledge. People learn faster when they actively process information, solve problems and practice skills.

Motivate: Inspire the class so that teaching does not become a one-way process of knowledge download. Learners will learn faster when they feel an inner urge to learn and be an active participant in the class.

Create a learning environment in which the learners feel free and able to shed their inhibitions and develop receptivity towards new ideas and concepts.

Students will have different motivation levels - some will be more eager to learn than others as each leaner is different from the other and therefore need to be treated differently.

And remember - adapt your communication style to suit the needs of the audience.

Communicate effectively: Communicate in a manner that is understood by the class. The language and sentence structuring should be clear and succinct.

Technical concepts should be explained in a manner that de-mystifies the concept - make things simple and easy to understand.

Avoid using *too much* technical jargon - if it is part of the curriculum, ensure the class is first made familiar with the words or jargon used.

Assessments: Conduct skill and knowledge checks regularly:

- Reinforce high order concepts at regular intervals.
- Conduct formative and summative assessments.
- Strengthen areas which appear to be weak.

Regular feedback:

- Provide regular feedback to learners
- Help them identify their strengths and areas of improvement
- Feedback should always be constructive
- Timely and specific feedback is easier to accept and act on

List of Icons

Icon Name	Icon
Module content	
Learning outcomes	
Performance criteria	
Contents	
Assessment criteria	
Resources required	
Information sheet	
Self-check Quiz	
Answer key	
Activity	
Video reference	
Learner job sheet	
Assessment plan	
Review of competency	

Module 1: Perform basic lathe machine operations

Module Descriptor:	This module covers the knowledge, skills and attitudes required to perform basic lathe machine operations. It specifically includes identifying and preparing work requirements, preparing for lathe operation and performing simple lathe operations such as facing, straight and contour turning, cutting grooves, drilling, boring, and thread cutting.	
Nominal Duration:	20 hours	
Learning Outcomes:	**1.1.**	Identify and prepare work requirements
	1.2.	Prepare for lathe operations
	1.3.	Perform basic lathe machine operations
Performance Criteria:	**1.1.**	Drawings are interpreted to grind tools confirming to the specifications.
	1.2.	Tool holding devices are selected according to the requirements of the operation.
	1.3.	Cutting tools are selected according to requirements of the lathe operation.
	1.4.	Appropriate types of lathe machine are selected for different lathe operations.
	1.5.	Lathe accessories are used in accordance with the requirements of the operations.
	1.6.	Cutting speed, feed and depth of cut are selected in accordance with the job specifications.
	1.7.	Job materials are selected and collected in accordance with the job specifications.
	1.8.	Cutting tools are selected in accordance with the requirements of the operation.
	1.9.	Sequence of operation is determined to produce products to the specifications.
	1.10.	RPM, cutting speed, feed and depth of cut are calculated in accordance with the job requirement.
	1.11.	Machine performance is checked in conformance with the job requirement.
	1.12.	Coolant is applied to prevent over heating of work piece and cutting tool.
	1.13.	Basic lathe operations are performed to produce component.
	1.14.	Corrective measures/adjustments are performed if necessary.
	1.15.	Workpiece is checked and measured in conformance to specification using appropriate methods, measuring tools and equipment.

Learning Outcome 1.1 - Identify and Prepare Work Requirements

<table>
<tr><td>Contents:</td><td colspan="3">▪ Interpret drawings to grind tools confirming to the specifications
▪ Select tool holding devices according to the requirements of the operation
▪ Select cutting tools according to requirements of the lathe operation</td></tr>
<tr><td>Resources Required:</td><td colspan="3">▪ Workplace (simulated or actual)
▪ Relevant drawings, manuals, codes, standards and reference material
▪ Tools holding devices and cutting tools appropriate to processes or activities
▪ Stationery
▪ Instruction sheet/manual
▪ Personal protective equipment (PPE)</td></tr>
<tr><td rowspan="4">Learning Activities:</td><td>Activity</td><td>Resource</td><td>Student Guide Page</td></tr>
<tr><td>1.1.1</td><td>▪ Information Sheet 1.1.1
▪ Self-Check 1.1.1
▪ Answer Key 1.1.1</td><td>7
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28</td></tr>
<tr><td>1.1.2</td><td>▪ Information Sheet 1.1.2
▪ Self-Check Quiz 1.1.2
▪ Answer Key 1.1.2</td><td>10
11
28</td></tr>
<tr><td>1.1.3</td><td>▪ Information Sheet 1.1.3
▪ Self-Check Quiz 1.1.3
▪ Answer Key 1.1.3</td><td>11
12
28</td></tr>
<tr><td>Assessment Criteria:</td><td colspan="3">▪ Drawings are interpreted to grind tools confirming to the specifications
▪ Tool holding devices are selected according to the requirements of the operation
▪ Cutting tools are selected according to requirements of the lathe operation</td></tr>
</table>

Learning Outcome 1.2 - Prepare for Lathe Operations

<table>
<tr><td>Contents:</td><td colspan="3">▪ Select appropriate types of lathe machine for different lathe operations
▪ Use lathe accessories in accordance with the requirements of the operations
▪ Select cutting speed, feed and depth of cut in accordance with the job specifications</td></tr>
<tr><td>Resources Required:</td><td colspan="3">▪ Workplace (simulated or actual)
▪ Relevant drawings, manuals, codes, standards and reference material
▪ Lathe machine and accessories, cutting tools appropriate to processes or activities
▪ Stationery
▪ Instruction sheet/manual
▪ Personal protective equipment (PPE)</td></tr>
<tr><td rowspan="4">Learning Activities:</td><td>Activity</td><td>Resource</td><td>Student Guide Page</td></tr>
<tr><td>1.2.1</td><td>▪ Information Sheet 1.2.1
▪ Self-Check Quiz 1.2.1
▪ Answer Key 1.2.1</td><td>13
15
28</td></tr>
<tr><td>1.2.2</td><td>▪ Information Sheet 1.2.2
▪ Self-Check Quiz 1.2.2
▪ Answer Key 1.2.2</td><td>15
17
28</td></tr>
<tr><td>1.2.3</td><td>▪ Information Sheet 1.2.3
▪ Self-Check Quiz 1.2.3
▪ Answer Key 1.2.3</td><td>18
19
28</td></tr>
<tr><td>Assessment Criteria:</td><td colspan="3">▪ Appropriate types of lathe machine are selected for different lathe operations
▪ Lathe accessories are used in accordance with the requirements of the operations
▪ Cutting speed, feed and depth of cut are selected in accordance with the job specifications</td></tr>
</table>

Learning Outcome 1.3 - Perform Basic Lathe Machine Operations

Contents:	▪ Perform basic lathe operations to produce component ▪ Perform corrective measures/adjustments if necessary ▪ Check and measure workpiece in conformance to specification using appropriate methods, measuring tools and equipment		
Resources Required:	▪ Workplace (simulated or actual) ▪ Relevant drawings, manuals, codes, standards and reference material ▪ Lathe machine and accessories, cutting tools appropriate to processes or activities ▪ Stationery ▪ Instruction sheet/manual ▪ Personal protective equipment (PPE)		
Learning Activities:	**Activity**	**Resource**	**Student Guide Page**
	1.3.1	▪ Information Sheet 1.3.1 ▪ Self-Check Quiz 1.3.1 ▪ Answer Key 1.3.1	22 24 28
	1.3.2	▪ Information Sheet 1.3.2 ▪ Self-Check Quiz 1.3.2 ▪ Job Sheet 1 ▪ Answer Key 1.3.2	24 24 26 29
Assessment Criteria:	▪ Basic lathe operations are performed to produce component ▪ Corrective measures/adjustments are performed ▪ Workpiece is checked and measured in conformance to specification using appropriate methods, measuring tools and equipment		

Module 2: Perform basic milling operations

Module Descriptor:	This module covers the knowledge, skills and attitudes required to perform basic milling machine operations. It specifically includes identifying and preparing work requirements, preparing for milling operation and performing simple milling operations such as plain and side milling, face milling, gang and straddle milling, slot milling and end milling operation.	
Nominal Duration:	20 hours	
Learning Outcomes:	**2.1.**	Identify and prepare work requirements
	2.2.	Prepare for milling operation
	2.3.	Perform basic milling operations
Performance Criteria:	**2.1.**	Drawings and specification are interpreted in relation to different milling operation.
	2.2.	Tool holding devices are selected according to the requirements of the operation.
	2.3.	Cutting tools are selected according to requirements of the milling operation.
	2.4.	Appropriate types of milling machine are selected for different milling operations.
	2.5.	Milling accessories are used in accordance with the requirements of the operations.
	2.6.	Cutting speed, feed and depth of cut are selected in accordance with the job specifications.
	2.7.	Job materials are selected and collected in accordance with the job specifications.
	2.8.	Cutting tools are selected in accordance with the requirements of the operation.
	2.9.	Sequence of operation is determined to produce products to the specifications.
	2.10.	Cutting speed and feed are calculated in accordance with the job requirement.
	2.11.	Machine performance is checked in conformance with the job requirement.
	2.12.	Coolant is applied to prevent over heating of work piece and cutting tool.
	2.13.	Basic milling operations are performed to produce component.
	2.14.	Corrective measures/adjustments are performed if necessary.
	2.15.	Workpiece is checked and measured in conformance to specification using appropriate methods, measuring tools and equipment.

Learning Outcome 2.1 - Identify and Prepare Work Requirements

<table>
<tr><td>Contents:</td><td colspan="3">▪ Interpret drawings and specification in relation to different milling operations
▪ Select tool holding devices according to the requirements of the operations
▪ Select cutting tools according to requirements of the milling operations</td></tr>
<tr><td>Resources Required:</td><td colspan="3">▪ Workplace (simulated or actual)
▪ Relevant drawings, manuals, codes, standards and reference material
▪ Tools holding devices and cutting tools appropriate to processes or activities
▪ Stationery
▪ Instruction sheet/manual
▪ Personal protective equipment (PPE)</td></tr>
<tr><td rowspan="4">Learning Activities:</td><td>Activity</td><td>Resource</td><td>Student Guide Page</td></tr>
<tr><td>2.1.1</td><td>▪ Information Sheet 2.1.1
▪ Self-Check Quiz 2.1.1
▪ Answer Key 2.1.1</td><td>31
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58</td></tr>
<tr><td>2.1.2</td><td>▪ Information Sheet 2.1.2
▪ Self-Check Quiz 2.1.2
▪ Answer Key 2.1.2</td><td>34
37
58</td></tr>
<tr><td>2.1.3</td><td>▪ Information Sheet 2.1.3
▪ Self-Check Quiz 2.1.3
▪ Answer Key 2.1.3</td><td>38
39
58</td></tr>
<tr><td>Assessment Criteria:</td><td colspan="3">▪ Drawings and specification are interpreted in relation to different milling operations
▪ Tool holding devices are selected according to the requirements of the operations
▪ Cutting tools are selected according to requirements of the milling</td></tr>
</table>

Learning Outcome 2.2 - Prepare for Milling Operations

Contents:	▪ Select different types of milling machine for different milling operations ▪ Use milling accessories in accordance with the requirements of the operations ▪ Select cutting speed and feed rate in accordance with the job specifications		
Resources Required:	▪ Workplace (simulated or actual) ▪ Relevant drawings, manuals, codes, standards and reference material ▪ Milling machine and accessories, cutting tools appropriate to processes or activities ▪ Stationery ▪ Instruction sheet/manual ▪ Personal protective equipment (PPE)		
Learning Activities:	**Activity**	**Resource**	**Student Guide Page**
	2.2.1	▪ Information Sheet 2.2.1 ▪ Self-Check Quiz 2.2.1 ▪ Answer Key 2.2.1	40 43 58
	2.2.2	▪ Information Sheet 2.2.2 ▪ Self-Check Quiz 2.2.2 ▪ Answer Key 2.2.2	44 48 58
	2.2.3	▪ Information Sheet 2.2.3 ▪ Self-Check Quiz 2.2.3 ▪ Answer Key 2.2.3	49 51 58
Assessment Criteria:	▪ Different types of milling machine are selected for different milling operations ▪ Milling accessories are used in accordance with the requirements of the operations ▪ Cutting speed and feed rate are selected in accordance with the job specifications		

Learning Outcome 2.3 - Perform Basic Milling Machine Operations

Contents:	▪ Perform basic milling operations to produce component ▪ Check and measure workpiece in conformance to specification using appropriate methods, measuring tools and equipment		
Resources Required:	▪ Workplace (simulated or actual) ▪ Relevant drawings, manuals, codes, standards and reference material ▪ Milling machine and accessories, cutting tools appropriate to processes or activities ▪ Stationery ▪ Instruction sheet/manual ▪ Personal protective equipment (PPE)		
Learning Activities:	**Activity**	**Resource**	**Student Guide Page**
	2.3.1	▪ Information Sheet 2.3.1 ▪ Self-Check Quiz 2.3.1 ▪ Answer Key 2.3.1	52 54 58
	2.3.2	▪ Information Sheet 2.3.2 ▪ Self-Check Quiz 2.3.2 ▪ Job Sheet 2 ▪ Answer Key 2.3.2	55 55 56 59
Assessment Criteria:	▪ Basic milling operations are performed to produce component ▪ Corrective measures/adjustments are performed ▪ Workpiece is checked and measured in conformance to specification using appropriate methods, measuring tools and equipment		

Module 3: Carry out CNC lathe machine operations

Module Descriptor:	This module covers the knowledge, skills and attitudes required to carry out CNC lathe machine operations. It specifically includes setting-up CNC lathe machine, downloading/inputting program, cutting model/sample work piece, performing CNC lathe machine operation, checking and measuring work piece and maintaining CNC lathe machine, tools and equipment.	
Nominal Duration:	60 hours	
Learning Outcomes:	**3.1.**	Set-up CNC lathe machine, workpiece and cutting tools
	3.2.	Cut model/sample workpiece
	3.3.	Perform CNC lathe machine operations
	3.4.	Maintain CNC lathe machine, tools and equipment
Performance Criteria:	**3.1.**	Oil, coolant, air and hydraulic is checked in accordance with manufacturer's specification.
	3.2.	Machine zero point is set to the required position.
	3.3.	Cutting tools are set according to required sequence of operations.
	3.4.	Work holding and clamping devices are set and tightened according to standard operating procedures.
	3.5.	Dry run is performed in accordance with the desired tool movement.
	3.6.	Work piece is cut as programmed and is checked and measured using appropriate measuring instruments.
	3.7.	Program is edited and tool parameters are corrected/adjusted as required.
	3.8.	Work piece is mounted or set in accordance with standard operating procedures.
	3.9.	CNC lathe operations are performed to produce component as programmed.
	3.10.	Work piece is checked and measured in conformance to specification using appropriate methods, measuring tools and equipment.
	3.11.	Proper shutdown is carried out in accordance with standard operating procedures.
	3.12.	Ensuring security of data, including regular back-ups and virus checks are implemented in accordance with standard operating procedures.
	3.13.	Basic file maintenance procedures are implemented in line with the standard operating procedures.
	3.14.	CNC lathe machine is cleaned and maintained with the standard operating procedures.
	3.15.	Tools, equipment and materials are stored safely in appropriate location according to standard work place procedures.

Learning Outcome 3.1 - Set-Up CNC Lathe Machine, Workpiece and Cutting Tools

<table>
<tr><td>Contents:</td><td colspan="3">▪ Check oil, coolant, air and hydraulic in accordance with manufacturer's specification
▪ Set machine zero point to the required position
▪ Set cutting tools according to required sequence of operations
▪ Set work holding and clamping devices and tightened according to standard operating procedures</td></tr>
<tr><td>Resources Required:</td><td colspan="3">▪ Workplace (simulated or actual)
▪ Relevant drawings, manuals, codes, standards and reference material
▪ CNC lathe machine, cutting tools, clamping devices and accessories
▪ Stationery
▪ Instruction sheet/manual
▪ Personal protective equipment (PPE)</td></tr>
<tr><td rowspan="5">Learning Activities:</td><td>Activity</td><td>Resource</td><td>Student Guide Page</td></tr>
<tr><td>3.1.1</td><td>▪ Information Sheet 3.1.1
▪ Self-Check Quiz 3.1.1
▪ Answer Key 3.1.1</td><td>62
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77</td></tr>
<tr><td>3.1.2</td><td>▪ Information Sheet 3.1.2
▪ Self-Check Quiz 3.1.2
▪ Answer Key 3.1.2</td><td>62
63
77</td></tr>
<tr><td>3.1.3</td><td>▪ Information Sheet 3.1.3
▪ Self-Check Quiz 3.1.3
▪ Answer Key 3.1.3</td><td>63
64
77</td></tr>
<tr><td>3.1.4</td><td>▪ Information Sheet 3.1.4
▪ Self-Check Quiz 3.1.4
▪ Answer Key 3.1.4</td><td>64
65
77</td></tr>
<tr><td>Assessment Criteria:</td><td colspan="3">▪ Oil, coolant, air and hydraulic is checked in accordance with manufacturer's specification
▪ Machine zero point is set to the required position
▪ Cutting tools are set according to required sequence of operations
▪ Work holding and clamping devices are set and tightened according to standard operating procedures</td></tr>
</table>

Learning Outcome 3.2 - Cut Model/Sample Workpiece

<table>
<tr><td>Contents:</td><td colspan="3">▪ Perform dry run in accordance with the desired tool movement
▪ Cut work piece as programmed and check and measure using appropriate measuring instruments
▪ Edit program and correct/adjust tool parameters as required</td></tr>
<tr><td>Resources Required:</td><td colspan="3">▪ Workplace (simulated or actual)
▪ Relevant drawings, manuals, codes, standards and reference material
▪ CNC lathe machine, cutting tools, clamping devices and accessories
▪ Stationery
▪ Instruction sheet/manual
▪ Personal protective equipment (PPE)</td></tr>
<tr><td rowspan="4">Learning Activities:</td><td>Activity</td><td>Resource</td><td>Student Guide Page</td></tr>
<tr><td>3.2.1</td><td>▪ Information Sheet 3.2.1
▪ Self-Check Quiz 3.2.1
▪ Answer Key 3.2.1</td><td>66
67
77</td></tr>
<tr><td>3.2.2</td><td>▪ Information Sheet 3.2.2
▪ Self-Check Quiz 3.2.2
▪ Answer Key 3.2.2</td><td>67
68
77</td></tr>
<tr><td>3.2.3</td><td>▪ Information Sheet 3.2.3
▪ Self-Check Quiz 3.2.3
▪ Answer Key 3.2.3</td><td>68
68
77</td></tr>
<tr><td>Assessment Criteria:</td><td colspan="3">▪ Dry run is performed in accordance with the desired tool movement
▪ Work piece is cut as programmed and is checked and measured using appropriate measuring instruments
▪ Program is edited and tool parameters are corrected/adjusted as required</td></tr>
</table>

Learning Outcome 3.3 - Perform CNC Lathe Machine Operations

Contents:	▪ Mount work piece or set in accordance with standard operating procedures ▪ Perform CNC lathe operations to produce component as programmed		
Resources Required:	▪ Workplace (simulated or actual) ▪ Relevant drawings, manuals, codes, standards and reference material ▪ CNC lathe machine, cutting tools, clamping devices and accessories ▪ Stationery ▪ Instruction sheet/manual ▪ Personal protective equipment (PPE)		
Learning Activities:	**Activity**	**Resource**	**Student Guide Page**
	3.3.1	▪ Information Sheet 3.3.1 ▪ Self-Check Quiz 3.3.1 ▪ Answer Key 3.3.1	69 70 78
	3.3.2	▪ Information Sheet 3.3.2 ▪ Self-Check Quiz 3.3.2 ▪ Answer Key 3.3.2 https://www.youtube.com/watch?v=bdIXXGIj4Sw https://www.youtube.com/watch?v=NCEHRvFQqMo	70 71 78
Assessment Criteria:	▪ Work piece is mounted or set in accordance with standard operating procedures ▪ CNC lathe operations are performed to produce component as programmed		

Learning Outcome 3.4 - Maintain CNC Lathe Machine, Tools and Equipment

Contents:	▪ Carry out proper shutdown in accordance with standard operating procedures ▪ Implement basic file maintenance procedures in line with the standard operating procedures		
Resources Required:	▪ Workplace (simulated or actual) ▪ Relevant drawings, manuals, codes, standards and reference material ▪ CNC lathe machine, cutting tools, clamping devices and accessories ▪ Stationery ▪ Instruction sheet/manual ▪ Personal protective equipment (PPE)		
Learning Activities:	**Activity**	**Resource**	**Student Guide Page**
	3.4.1	▪ Information Sheet 3.4.1 ▪ Self-Check Quiz 3.4.1 ▪ Answer Key 3.4.1	72 73 78
	3.4.2	▪ Information Sheet 3.4.2 ▪ Self-Check Quiz 3.4.2 ▪ Job Sheet 3 ▪ Answer Key 3.4.2	73 74 75 78
Assessment Criteria:	▪ Proper shutdown is carried out in accordance with standard operating procedures ▪ Basic file maintenance procedures are implemented in line with the standard operating procedures		

Module 4: Carry out CNC milling machine Operations

Module Descriptor:	This module covers the knowledge, skills and attitudes required to carry out CNC milling machine operations. It specifically includes setting-up CNC milling machine, downloading/inputting program, cutting model/sample work piece, performing CNC milling machine operations, checking and measuring work piece and maintaining CNC milling machine, tools and equipment.	
Nominal Duration:	80 hours	
Learning Outcomes:	**4.1.**	Set-up CNC milling machine, workpiece and cutting tools
	4.2.	Cut model/sample workpiece
	4.3.	Perform CNC milling machine operations
	4.4.	Maintain CNC milling machine, tools and equipment
Performance Criteria:	**4.1.**	Oil, coolant, air and hydraulic is checked in accordance with manufacturer's specification.
	4.2.	Machine zero point is set to the required position.
	4.3.	Cutting tools are set according to required sequence of operations.
	4.4.	Work holding and clamping devices are set and tightened according to standard operating procedures.
	4.5.	Dry run is performed in accordance with the desired tool movement.
	4.6.	Work piece is cut as programmed and is checked and measured using appropriate measuring instruments.
	4.7.	Program is edited and tool parameters are corrected/adjusted as required.
	4.8.	Work piece is mounted or set in accordance with standard operating procedures.
	4.9.	CNC milling operations are performed to produce component as programmed.
	4.10.	Work piece is checked and measured in conformance to specification using appropriate methods, measuring tools and equipment.
	4.11.	Proper shutdown is carried out in accordance with standard operating procedures.
	4.12.	Ensuring security of data, including regular back-ups and virus checks are implemented in accordance with standard operating procedures.
	4.13.	Basic file maintenance procedures are implemented in line with the standard operating procedures.
	4.14.	CNC milling machine are cleaned and maintained with the standard operating procedures.
	4.15.	Tools, equipment and materials are stored safely in appropriate location according to standard work place procedures.

Learning Outcome 4.1 - Set-Up CNC Milling Machine, Workpiece and Cutting Tools

<table>
<tr><td>Contents:</td><td colspan="3">▪ Check oil, coolant, air and hydraulic in accordance with manufacturer’s specification
▪ Set machine zero point to the required position
▪ Set cutting tools according to required sequence of operations
▪ Set work holding and clamping devices and tightened according to standard operating procedures</td></tr>
<tr><td>Resources Required:</td><td colspan="3">▪ Workplace (simulated or actual)
▪ Relevant drawings, manuals, codes, standards and reference material
▪ CNC milling machine, cutting tools, clamping devices and accessories
▪ Stationery
▪ Instruction sheet/manual
▪ Personal protective equipment (PPE)</td></tr>
<tr><td rowspan="5">Learning Activities:</td><td>Activity</td><td>Resource</td><td>Student Guide Page</td></tr>
<tr><td>4.1.1</td><td>▪ Information Sheet 4.1.1
▪ Self-Check Quiz 4.1.1
▪ Answer Key 4.1.1</td><td>82
82
99</td></tr>
<tr><td>4.1.2</td><td>▪ Information Sheet 4.1.2
▪ Self-Check Quiz 4.1.2
▪ Answer Key 4.1.2</td><td>82
83
99</td></tr>
<tr><td>4.1.3</td><td>▪ Information Sheet 4.1.3
▪ Self-Check Quiz 4.1.3
▪ Answer Key 4.1.3</td><td>83
84
99</td></tr>
<tr><td>4.1.4</td><td>▪ Information Sheet 4.1.4
▪ Self-Check Quiz 4.1.4
▪ Answer Key 4.1.4</td><td>85
85
99</td></tr>
<tr><td>Assessment Criteria:</td><td colspan="3">▪ Oil, coolant, air and hydraulic is checked in accordance with manufacturer’s specification
▪ Machine zero point is set to the required position
▪ Cutting tools are set according to required sequence of operations
▪ Work holding and clamping devices are set and tightened according to standard operating procedures</td></tr>
</table>

Learning Outcome 4.2 - Cut Model/Sample Workpiece

<table>
<tr><td>Contents:</td><td colspan="3">▪ Performed dry run in accordance with the desired tool movement
▪ Cut work piece as programmed and check and measure using appropriate measuring instruments
▪ Edit program and correct/adjust tool parameters as required</td></tr>
<tr><td>Resources Required:</td><td colspan="3">▪ Workplace (simulated or actual)
▪ Relevant drawings, manuals, codes, standards and reference material
▪ CNC milling machine, cutting tools, clamping devices and accessories
▪ Stationery
▪ Instruction sheet/manual
▪ Personal protective equipment (PPE)</td></tr>
<tr><td rowspan="4">Learning Activities:</td><td>Activity</td><td>Resource</td><td>Student Guide Page</td></tr>
<tr><td>4.2.1</td><td>▪ Information Sheet 4.2.1
▪ Self-Check Quiz 4.2.1
▪ Answer Key 4.2.1</td><td>86
87
99</td></tr>
<tr><td>4.2.2</td><td>▪ Information Sheet 4.2.2
▪ Self-Check Quiz 4.2.2
▪ Answer Key 4.2.</td><td>88
88
99</td></tr>
<tr><td>4.2.3</td><td>▪ Information Sheet 4.2.3
▪ Self-Check Quiz 4.2.3
▪ Answer Key 4.2.3</td><td>89
89
99</td></tr>
<tr><td>Assessment Criteria:</td><td colspan="3">▪ Dry run is performed in accordance with the desired tool movement
▪ Work piece is cut as programmed and is checked and measured using appropriate measuring instruments
▪ Program is edited and tool parameters are corrected/adjusted as required</td></tr>
</table>

Learning Outcome 4.3 - Perform CNC Milling Machine Operations

<table>
<tr><td>Contents:</td><td colspan="3">▪ Edit program and correct/adjust tool parameters as required
▪ Mount or set work piece in accordance with standard operating procedures
▪ Perform CNC milling operations to produce component as programmed</td></tr>
<tr><td>Resources Required:</td><td colspan="3">▪ Workplace (simulated or actual)
▪ Relevant drawings, manuals, codes, standards and reference material
▪ CNC milling machine, cutting tools, clamping devices and accessories
▪ Stationery
▪ Instruction sheet/manual
▪ Personal protective equipment (PPE)</td></tr>
<tr><td rowspan="4">Learning Activities:</td><td>Activity</td><td>Resource</td><td>Student Guide Page</td></tr>
<tr><td>4.3.1</td><td>▪ Information Sheet 4.3.1
▪ Self-Check Quiz 4.3.1
▪ Answer Key 4.3.1</td><td>90
91
100</td></tr>
<tr><td>4.3.2</td><td>▪ Information Sheet 4.3.2
▪ Self-Check Quiz 4.3.2
▪ Answer Key 4.3.2</td><td>91
92
100</td></tr>
<tr><td>4.3.3</td><td>▪ Information Sheet 4.3.3
▪ Self-Check Quiz 4.3.3
▪ Answer Key</td><td>92
93
100</td></tr>
<tr><td>Assessment Criteria:</td><td colspan="3">▪ Program is edited and tool parameters are corrected/adjusted as required
▪ Work piece is mounted or set in accordance with standard operating procedures
▪ CNC milling operations are performed to produce component as programmed</td></tr>
</table>

Learning Outcome 4.4 - Maintain CNC Milling Machine, Tools and Equipment

<table>
<tr><td>Contents:</td><td colspan="3">▪ Carry out proper shutdown in accordance with standard operating procedures
▪ Implement basic file maintenance procedures in line with the standard operating procedures</td></tr>
<tr><td>Resources Required:</td><td colspan="3">▪ Workplace (simulated or actual)
▪ Relevant drawings, manuals, codes, standards and reference material
▪ CNC milling machine, cutting tools, clamping devices and accessories
▪ Stationery
▪ Instruction sheet/manual
▪ Personal protective equipment (PPE)</td></tr>
<tr><td rowspan="3">Learning Activities:</td><td>Activity</td><td>Resource</td><td>Student Guide Page</td></tr>
<tr><td>4.4.1</td><td>▪ Information Sheet 4.4.1
▪ Self-Check Quiz 4.4.1
▪ Answer Key 4.4.1</td><td>94
95
100</td></tr>
<tr><td>4.4.2</td><td>▪ Information Sheet 4.4.2
▪ Self-Check Quiz 4.4.2
▪ Job Sheet 4
▪ Answer Key 4.4.2</td><td>95
96
97
100</td></tr>
<tr><td>Assessment Criteria:</td><td colspan="3">▪ Proper shutdown is carried out in accordance with standard operating procedures
▪ Basic file maintenance procedures are implemented in line with the standard operating procedures</td></tr>
</table>

Module 5: Review final output and print

Module Descriptor:	This module covers the knowledge, skills and attitudes required to carry out CNC wire cut machine operations. It specifically includes preparing for CNC wire cut machine operations, setting-up machine ,wire and work piece, downloading/inputting simulate program, performing CNC wire cut operation in auto mode, cleaning and storing tools and equipment.	
Nominal Duration:	40 hours	
Learning Outcomes:	**5.1.**	Prepare for CNC wire cut machine operations
	5.2.	Set-up machine, wire and workpiece
	5.3.	Perform CNC wire cut operation in auto mode
Performance Criteria:	**5.1.**	Wire (electrode) for CNC operations is selected conforming to the job requirement.
	5.2.	Performed routine maintenance to prepare the machine for required operations.
	5.3.	Machine zero position is set according to the required job position.
	5.4.	Wire (electrode) and feed roller are set according to required sequence of operations.
	5.5.	Machining parameters that may include wire offset, wire speed, power settings are selected.
	5.6.	Machine is operated in appropriate mode to test and prove program, work piece positioning.

Learning Outcome 5.1 - Prepare for CNC Wire Cut Machine Operations

Contents:	▪ Select wire (electrode) for CNC operations conforming to the job requirement ▪ Perform routine maintenance to prepare the machine for required operations		
Resources Required:	▪ Workplace (simulated or actual) ▪ Relevant drawings, manuals, codes, standards and reference material ▪ CNC wire cut machine, wire (electrode), clamping devices and accessories ▪ Stationery ▪ Instruction sheet/manual ▪ Personal protective equipment (PPE)		
Learning Activities:	**Activity**	**Resource**	**Student Guide Page**
	5.1.1	▪ Information Sheet 5.1.1 ▪ Self-Check Quiz 5.1.1 ▪ Answer Key 5.1.1	102 103 115
	5.1.2	▪ Information Sheet 5.1.2 ▪ Self-Check Quiz 5.1.2 ▪ Answer Key 5.1.2	104 105 115
Assessment Criteria:	▪ Wire (electrode) for CNC operations is selected conforming to the job requirement ▪ Routine maintenance to prepare the machine is performed for required operations		

Learning Outcome 5.2 - Set-Up Machine, Wire and Workpiece

<table>
<tr><td>Contents:</td><td colspan="3">▪ Set machine zero position according to the required job position
▪ Set wire (electrode) and feed roller according to required sequence of operations</td></tr>
<tr><td>Resources Required:</td><td colspan="3">▪ Workplace (simulated or actual)
▪ Relevant drawings, manuals, codes, standards and reference material
▪ CNC wire cut machine, wire (electrode), clamping devices and accessories
▪ Stationery
▪ Instruction sheet/manual
▪ Personal protective equipment (PPE)</td></tr>
<tr><td rowspan="3">Learning Activities:</td><td>Activity</td><td>Resource</td><td>Student Guide Page</td></tr>
<tr><td>5.2.1</td><td>▪ Information Sheet 5.2.1
▪ Self-Check Quiz 5.2.1
▪ Answer Key 5.2.1</td><td>106
107
115</td></tr>
<tr><td>5.2.2</td><td>▪ Information Sheet 5.2.2
▪ Self-Check Quiz 5.2.2
▪ Answer Key 5.2.2</td><td>108
109
115</td></tr>
<tr><td>Assessment Criteria:</td><td colspan="3">▪ Machine zero position is set according to the required job position
▪ Wire (electrode) and feed roller are set according to required sequence of operations</td></tr>
</table>

Learning Outcome 5.3 - Perform CNC Wire Cut Operation in Auto Mode

<table>
<tr><td>Contents:</td><td colspan="3">▪ Select machining parameters that may include wire offset, wire speed, power settings
▪ Operate machine in appropriate mode to test and prove program, work piece positioning</td></tr>
<tr><td>Resources Required:</td><td colspan="3">▪ Workplace (simulated or actual)
▪ Relevant drawings, manuals, codes, standards and reference material
▪ CNC wire cut machine, wire (electrode), clamping devices and accessories
▪ Stationery
▪ Instruction sheet/manual
▪ Personal protective equipment (PPE)</td></tr>
<tr><td rowspan="3">Learning Activities:</td><td>Activity</td><td>Resource</td><td>Student Guide Page</td></tr>
<tr><td>5.3.1</td><td>▪ Information Sheet 5.3.1
▪ Self-Check Quiz 5.3.1
▪ Answer Key 5.3.1</td><td>110
111
115</td></tr>
<tr><td>5.3.2</td><td>▪ Information Sheet 5.3.2
▪ Self-Check Quiz 5.3.2
▪ Job Sheet 5
▪ Answer Key 5.3.2</td><td>112
113
113
115</td></tr>
<tr><td>Assessment Criteria:</td><td colspan="3">▪ Machining parameters that may include wire offset, wire speed, power settings are selected
▪ Machine is operated in appropriate mode to test and prove program, work piece positioning</td></tr>
</table>

Module 6: Apply knowledge of CAM

Module Descriptor:	This module covers the knowledge, skills and attitudes required to apply CAM program. It specifically includes the tasks of preparing for CAM program, importing CAD model, editing CNC program, loading and running program at CNC machine.	
Nominal Duration:	20 hours	
Learning Outcomes:	**6.1.**	Prepare for CAM program, edit CNC program, load program and run program at CNC machine
Performance Criteria:	**6.1.**	CNC Parameters are selected according to the requirements of the operation.
	6.2.	Tools and equipment are gathered to produce drawing as per requirement.
	6.3.	CAM parameters are identified and set according to job requirements and part to be produced.
	6.4.	CNC program generated through post processor in accordance with selected CNC machine control standard.

Learning Outcome 6.1 - Prepare for Cam Program, Edit CNC Program, Load Program and Run Program at CNC Machine

<table>
<tr><td>Contents:</td><td colspan="3">▪ Select CNC parameters according to the requirements of the operation
▪ Gather tools and equipment to produce drawing as per requirement
▪ Identify and set CAM parameters according to job requirements and part to be produced</td></tr>
<tr><td>Resources Required:</td><td colspan="3">▪ Workplace (simulated or actual)
▪ Relevant drawings, manuals, codes, standards and reference material
▪ CNC machine, wire (electrode), clamping devices and accessories
▪ Stationery
▪ Instruction sheet/manual
▪ Personal protective equipment (PPE)</td></tr>
<tr><td rowspan="2">Learning Activities:</td><td>Activity</td><td>Resource</td><td>Student Guide Page</td></tr>
<tr><td>6.1.1</td><td>▪ Information Sheet 6.1.1</td><td>117</td></tr>
<tr><td>Assessment Criteria:</td><td colspan="3">▪ CNC parameters are selected according to the requirements of the operation
▪ Tools and equipment are gathered to produce drawing as per requirement
▪ CAM parameters are identified and set according to job requirements and part to be produced</td></tr>
</table>