MACHINING
LEVEL – III

CURRICULUM

Based on December, 2021 (V- III) Occupational Standard (OS)

March, 2022
Addis Ababa, Ethiopia

Preface

The reformed TVET-System is an outcome-based system. It utilizes the needs of the labor market and occupational requirements from the world of work as the benchmark and standard for TVET delivery. The requirements from the world of work are analyzed and documented – taking into account international benchmarking – as occupational standards (OS).

In the reformed TVET-System, curricula and curriculum development play an important role with regard to quality driven comparable TVET-Delivery. The Curricula help to facilitate the training process in a way, that trainees acquire the set of occupational competences (skills, knowledge and attitude) required at the working place and defined in the occupational standards (OS).

This curriculum has been developed by a group of professional experts from different Regional TVET Bureaus, colleges, Industries, Institutes and universities based on the occupational standard for Machining LEVEL III

The curriculum development process has been actively supported and facilitated by **Ministry of Labor and Skills.**

TVET-Program Design

1.1. TVET-Program Title: Machining LEVEL III

1.2. TVET-Program Description

The Program is designed to develop the necessary knowledge, skills and attitude of the trainees to the standard required by the occupation. The contents of this program are in line with the occupational standard. The Trainees who successfully completed the Program will be qualified to work as a **machinist** with competencies elaborated in the respective OS. Graduates of the program will have the required qualification to work in the **Industry** sector in the field of Machining. The prime objective of this training program is to equip the Trainees with the identified competences specified in the OS. Graduates are therefore expected to Perform Advanced CAD/CAM Applications, Perform Advanced Lathe CNC Operations, Perform Advanced CNC Milling Operations, Perform Advanced Grinding Operations, Perform EDM Plunger and Wire Operations, Perform Advanced Press Operations, Perform Advanced Lathe Operations, Perform Advanced Milling Operations,in accordance with the performance criteria and evidence guide described in the OS.

1.3.TVET-Program Training Outcomes

The expected outputs of this program are the acquisition and implementation of the following units of competences:

IND MAC3 01 1221 Perform Advanced CAD/CAM Applications

IND MAC3 02 1221 Perform Advanced Lathe CNC Operations

IND MAC3 03 1221 Perform Advanced CNC Milling Operations

IND MAC3 04 1221 Perform Advanced Grinding Operations

IND MAC3 05 1221 Perform EDM Plunger and Wire Operations

IND MAC3 06 2021 Perform Advanced Press Operations

IND MAC3 07 1221 Perform Advanced Lathe Operations

IND MAC3 08 1221 Perform Advanced Milling Operations

1.4. Duration of the TVET-Program

The Program will have duration of **700 hours** including the on school/ Institution training and on-the-job practice or cooperative training time. Such cooperative training based on realities of the industry, nature of the occupation, location of the TVET institution, and other factors will

be considered in the training delivery to ensure that trainees acquire practical and workplace experience.

S.No	Unit Competency	TVET Institution Training		Cooperative Training	Total Hours	Remarks
		Theory	Practical			
1.	Perform Advanced CAD/CAM Applications	30	50	20	100	
2.	Perform Advanced Lathe CNC Operations	36	60	24	120	
3.	Perform Advanced CNC Milling Operations	36	60	24	120	
4.	Perform Advanced Grinding Operations	18	30	12	60	
5.	Perform EDM Plunger and Wire Operations	18	30	12	60	
6.	Perform Advanced Press Operations	12	20	8	40	
7.	Perform Advanced Lathe Operations	30	50	20	100	
8.	Perform Advanced Milling Operations	30	50	20	100	
Total Hours					**700 Hours**	

1.5.Qualification Level and Certification

Based on the descriptors elaborated on the Ethiopian National TVET Qualification Framework (NTQF) the qualification of this specific TVET Program is **Level III.**

The trainee can exit after successfully completing the modules in one level and will be awarded the equivalent institutional certificate on the level completed. However, only institutional certificate of training accomplishment will be awarded.

1.6.Target Groups

Any citizen **with or without disability** who meets the entry requirements under items 1.7 and capable of participating in the training activities is entitled to take part in the Program.

1.7 Entry Requirements

The prospective participants of this program are required to possess the requirements or directive of the **Ministry of Labor and Skills**.

1.8 Mode of Delivery

This TVET-Program is characterized as a formal Program on middle level technical skills. The mode of delivery is co-operative training. The time spent by the trainees in the real work place/ industry will give them enough exposure to the actual world of work and enable them to get hands-on experience. The co-operative approach will be supported with school-based lecture-discussion, simulation and actual practice. These modalities will be utilized before the trainees are exposed to the industry environment.

Hence based on the nature of the occupation, location of the TVET institutions, and interest of the industry alternative mode of cooperative training such as apprenticeships, internship and traineeship will be employed. In addition, in the areas where industry is not sufficiently available the established production and service centers/learning factories in TVET institutions will be used as cooperative training places. The Training-Institution and identified companies have forged an agreement to co-operate with regard to the implementation of this program.

1.9 TVET-Program Structure

Unit of Competence	Module Code & Title	Training Outcomes	Duration (In Hours)
IND MAC3 01 1221 Perform Advanced CAD/CAM Applications	IND MAC3 M01 0322 Performing Advanced CAD/CAM Applications	• Design detailed part drawing • Translate CAD in CNC machine program • Perform appropriate CAM / CNC operations • Comply with quality assurance	**100 hr**
IND MAC3 02 1221 Perform Advanced Lathe CNC Operations	IND MAC3 M02 0322 Performing Advanced Lathe CNC Operations	• Determine job requirements • Prepare CNC lathe machining process / Write program • Perform appropriate Lathe operations • Comply with Quality assurance	**120hr**

IND MAC3 03 1221	Perform Advanced CNC Milling Operations	IND MAC3 M03 0322	Performing Advanced CNC Milling Operations	• Determine job requirements • Write or load CNC milling machine program • Perform milling operations • Select materials • Produce and assemble components • Comply with Quality assurance	**120 hr**
IND MAC3 04 1221	Perform Advanced Grinding Operations	IND MAC3 M04 0322	Performing Advanced Grinding Operations	• Set up work • Perform advanced grinding operations • Perform tool and cutter grinding operation • Check components for conformance to specifications	**60 hr**
IND MAC3 05 1221	Perform EDM Plunger and Wire Operations	IND MAC3 M05 0322	Performing EDM Plunger and Wire Operations	• Determine work requirements • Prepare EDM machining operations • Perform electro-discharge machining (EDM) • Check components for	**60 hr**

				conformance to specification	
IND MAC3 06 2021	Perform Advanced Press Operations	**IND MAC3 M06 0322**	Performing Advanced Press Operations	• Determine work requirements • Prepare and perform press machine for operation • Fit die and mould parts • Set-up mould and molding machines • Operate mould and press machines • Monitor machine/process • Assure quality outcomes	**40 hr**
IND MAC3 07 1221	Perform Advanced Lathe Operations	**IND MAC3 M07 0322**	Performing Advanced Lathe Operations	• Determine job requirements • Setup work-piece • Perform lathe operations • Check/Measure work piece	**100hr**
IND MAC3 08 1221	Perform Advanced Milling Operations	**IND MAC3 M08 0322**	Performing Advanced Milling Operations	• Determine job requirements • Set-up work piece • Perform milling operations • Check/ Measure work piece	**100 hr**

*The time duration (Hours) indicated for the module should include all activities in and out of the TVET institute

1.10 Institutional Assessment

Two types of evaluation will be used in determining the extent to which training outcomes are achieved. The specific training outcomes are stated in the modules. In assessing them, verifiable and observable indicators and standards shall be used.

The **formative assessment** is incorporated in the training modules and form part of the training process. Formative evaluation provides the trainee with feedback regarding success or failure in attaining training outcomes. It identifies the specific training errors that need to be corrected, and provides reinforcement for successful performance as well. For the teacher, formative evaluation provides information for making instruction and remedial work more effective.

Summative Evaluation the other form of evaluation is given when all the modules in the program have been accomplished. It determines the extent to which competence have been achieved. And, the result of this assessment decision shall be expressed in the term of institutional Assessment implementation guidelines..

Techniques or tools for obtaining information about trainees' achievement include oral or written test, demonstration and on-site observation.

1.11 TVET Teachers Profile

The teachers conducting this particular TVET Program are B Level and above who have satisfactory practical experiences or equivalent qualifications.

LEARNING MODULE 01
TVET-PROGRAMME TITLE: **Machining LEVEL III**
MODULE TITLE : **Drawing Perform Advanced CAD/CAM Applications**
MODULE CODE : **IND MAC3 M01 0322**
NOMINAL DURATION : **100 Hours**
MODULE DESCRIPTION ፡ This Modules deals with the knowledge, skills and attitudes required to link designed advanced CAD 2D and 3D parts with programmed CAM/ CNC machining processes. Drawing components may include assembly, layout and detail drawings.

LEARNING OUTCOMES

At the end of the module the trainee will be able to:

LO1. Design detailed part drawing

LO2. Translate CAD in CNC machine program

LO3. Perform appropriate CAM / CNC operations

LO4. Comply with quality assurance

MODULE CONTENTS:

LO1. Design detailed part drawing

1.1.Checking and interpreting requirements and purpose of part drawing.

1.2.Determining and inserting all drawing details and specifications.

1.3.Produced drawing, including auxiliary views, sections and assemblies.

1.4.Determining and inserting, all drawing details and specifications.

1.5.Reviewing two-dimensional Computer Aided/Automated Design (CAD) blueprint.

LO2. Translate CAD in CNC machine program

2.1.Calculating coordinates for simple tool path machining functions.

2.2.Selecting tools and materials for the job and planning the sequence of cutting and finishing operations.

2.3.Writing Program into a Computer Aided Manufacturing (CAM) code / process.

2.4.Simulating and editing Program.

2.5.Downloading and storing Program.

LO3. Perform appropriate CAM / CNC operations

3.1.Setting tools and mounting parts.

3.2.Performing dry run.

3.3.Performing CAM/CNC operations to produce part

3.4.Performing Corrective measures/adjustments

3.5.Observing occupational health and safety procedures and environmental guidelines

LO4. Comply with quality assurance

4.1.Changing and retesting program if errors are found.

4.2.Checking and measuring designed part in conformance. ‘

4.3.Utilizing appropriate methods, measuring tools and equipment.

Learning Methods:				
For none impaired trainees	**Reasonable Adjustment for Trainees with Disability (TWD)**			
	Low Vision	**Deaf**	**Hard of hearing**	**Physical impairment**
Lecture discussion	❖ Provide large print text ❖ Prepare the lecture in **Audio/video** ❖ Organize the class room seating arrangement to be accessible to trainees ❖ Write short notes on the black/white board using large text ❖ Make sure the luminosity of the light of class room is kept ❖ Use normal tone of voice ❖ Encourage trainees to record the lecture in audio format ❖ Provide Orientation on the physical feature of the work shop ❖ Summarize main points	❖ Assign sign language interpreter ❖ Arrange the class room seating to be conducive for eye to eye contact ❖ Make sure the luminosity of the light of class room is kept ❖ Introduce new and relevant vocabularies ❖ Use short and clear sentences ❖ Give emphasis on visual lecture and ensure the attention of the trainees ❖ Avoid movement during lecture time ❖ Present the lecture in video format	❖Organize the class room seating arrangement to be accessible to trainees ❖Speak loudly ❖Ensure the attention of the trainees ❖Present the lecture in video format ❖Ensure the attention of the trainees	❖Organize the class room seating arrangement to be accessible for wheelchairs users. ❖ Facilitate and support the trainees who have severe impairments on their upper limbs to take note ❖ Provide Orientation on the physical feature of the work shop

		❖ Summarize main points		
Demonstration	❖ Conduct close follow up ❖ Use verbal description ❖ Provide special attention in the process of guidance ❖ facilitate the support of peer trainees ❖ Prepare & use simulation	❖ use Sign language interpreter ❖ Use video recorded material ❖ Ensure attention of the trainees ❖ Provide structured training ❖ Show clear and short method ❖ Use gesture ❖ provide tutorial support (if necessary)	❖ Illustrate in clear & short method ❖ Use Video recorded material ❖ Ensure the attention of the trainees ❖ provide tutorial support (if necessary)	❖Facilitate and support the trainees having severe upper limbs impairment to operate equipment / machines ❖Assign peer trainees to assist ❖Conduct close follow up ❖ provide tutorial support (if necessary
Group discussion	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member ❖ Brief the thematic issues of the work	❖ Use sign language interpreters ❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Introduce the trainees with their peers

			❖ Inform the group members to speak loudly	
Exercise	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/practical training ❖ Introduce new and relevant vocabularies	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/ practical training	❖ Assign peer trainees ❖ Use additional nominal hours if necessary
Individual assignment	❖ prepare the assignment questions in large text ❖ Encourage the trainees to prepare and submit the assignment in large texts ❖ Make available recorded assignment questions ❖ Facilitate the trainees to prepare and submit the assignment in soft or hard copy	❖ Use sign language interpreter ❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	

ASSESSMENT METHODS:				
Interview		❖Use sign language interpreter ❖Ensure or conform whether the proper communication was conducted with the trainee through the service of the sign language interpreter ❖Use short and clear questioning ❖Time extension	❖Speak loudly ❖Using sign language interpreter if necessary	❖ Use written response as an option for the trainees having speech challenges
Written test	❖ Prepare the exam in large texts ❖ Use interview as an option if necessary ❖ Prepare the exam in audio format ❖ Assign human reader ❖ (if necessary) ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, True or False, matching and short answers ❖ Avoid essay writing ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, true or false, matching and short answers if necessary.	❖Use oral response as an option to give answer for trainees having severe upper limb impairment ❖Time extension for trainees having severe upper limb impairment
Demonstration /Observation	❖ Brief the instruction or provide them in large text	❖Use sign language interpreter ❖Brief on the instruction of the	❖Provide activity based assessment ❖Brief on the instruction of the exam	❖ Provide activity based assessment

	❖ Time extension	❖Provide activity-based/ practical assessment method ❖Time extension	❖ Use loud voice ❖ Time extension	❖Conduct close follow up ❖Time extension

ASSESSMENT CRITERIA:

LO1. Design detailed part drawing

- Requirements and purpose of part are checked and interpreted drawing from work order, from workshop manuals, customer specifications, product suppliers, and designers
- All drawing details and specifications are determined and inserted to ensure functional operation and suitability with accordance to standard.
- Drawing, including auxiliary views, sections and assemblies in ISO first and third angle projection are produced
- All drawing details and specifications are determined and inserted, which includes limits and fits, surface texture, datum references and geometric tolerances to ensure functional operation and suitability according to standard
- Two-dimensional Computer Aided/Automated Design (CAD) blueprint of the part is reviewed for CAM application in compliance with standards

LO2. Translate CAD in CNC machine program

- Coordinates are calculated for simple tool path machining functions based on drafted part to be produced
- Tools and materials for the job are selected and the sequence of cutting and finishing operations are planned based on operational procedures
- Program is written into a standardized Computer Aided/Automated Manufacturing (CAM) code / process
- Program is simulated and edited according to standard operating procedure
- Program is downloaded and stored according to standard operating procedures.

LO3. Perform appropriate CAM / CNC operations

- Tools are set and part is mounted or set in accordance with standard operating procedures
- Dry run is performed in accordance with the desired tool path movement
- CAM/CNC operations are performed to produce part according to CAD drawing specifications

- Corrective measures/adjustments are performed if necessary based on operational procedures
- Occupational health and safety procedures and environmental guidelines are observed throughout the operation

LO4. Comply with quality assurance

- Program must be changed if errors are found and retested until program is effective based on operational procedures
- Designed part is checked and measured in conformance to specification and quality outcomes
- Appropriate methods, measuring tools and equipment are utilized in accordance with standard

Annex: Resource Requirements

IND MAC3 M01 0322 Advanced CAD/CAM Applications				
Item No.	**Category/Item**	**Description/ Specifications**	**Quantity**	**Recommended Ratio (Item: Trainee)**
A.	**Learning Materials**			
1.	TTLM	TTTLM prepared by Trainer	25pcs	1:1
2.	Reference Books	1. CAD/CAM/CIM 3rd edition by P. Rad hakrishnan S. Subramanian V. Raju 2. Paul G Ranky – Computer Integrated Manufacturing - prentice /Hall Intern;	5 pcs	1:5
B.	**Learning Facilities & Infrastructure**			
1.	Lecture room / work shop	5m *10m	1 pcs	1:25
2.	Library	With sufficient books	1 pcs	1:25
C.	**Consumable Materials**			
1.	White Board marker	Any type	1Pack	1:5
2.	Copy A4 paper	Double A	1 pack	1:5
D.	**Tools and Equipment**			

1.	White Board	**1000mm*2000mm**	1 pcs	1:5
2.	Desk top computer	**Dell**	25 pcs	1:1
3.	Cad Software			
	• Auto CAD	2007, 2018	25	1:1
	• Solid works	2018	25	1:1
	• CATIA	2018	25	1:1
	• Master CAM		25	1:1
4.	LCD Projector	055-inch wide panel(D7)	1 pcs	1:25

LEARNING MODULE 02
TVET-PROGRAMME TITLE: **Machining LEVEL III**
MODULE TITLE : **Performing Advanced Lathe CNC Operations**
MODULE CODE : **INDMAC3 M02 0322**
NOMINAL DURATION : **120 Hours**
MODULE DESCRIPTION : This module covers the knowledge, attitudes and skills needed to perform advanced CNC lathe machining operations which includes programming and set up

LEARNING OUTCOMES

At the end of the module the trainee will be able to:

LO1. Determine job requirements

LO2. Prepare CNC lathe machining process / Write program

LO3. Perform appropriate Lathe operations

LO4. Comply with Quality assurance

MODULE CONTENTS:

LO1. Determine job requirements

1.1. Interpreting drawings.

1.2. Determining sequence of operation.

1.3. Selecting cutting tools, instruments and machine accessories.

1.4. Calculating cutting speed and feeds rate.

1.5. Filling up Process/job/adjustment sheets.

LO2. Prepare CNC lathe machining process / Write program

2.1. Calculating coordinates.

2.2. Standardizing program in CNC lathe operations,

2.3. Simulating and edited Program.

2.4. Documenting and saving program.

2.5. Downloading program to the machine.

LO3. Perform appropriate Lathe operations

3.1 Mounting work-piece.

3.2 Performing dry run.

3.3 Performing advance CNC lathe operations.

3.3.1 Automatic parallel and taper turning

3.3.2 Internal and external turning

3.3.3 Thread cutting

3.3.4 eccentric turning

3.4 Performing Corrective measures/adjustments.

3.4.1 Replacement of cutting tools

3.4.2 Adjustment of tool offset

3.4.3 Adjustment of cutting speed and federate

3.6 Observing occupational health and safety.

LO4. Comply with Quality assurance

4.1. Checking components.

4.2. Handling deviations.

4.3. Comparing product quality of the CNC production with conventional production.

Learning Methods:				
For none impaired trainees	**Reasonable Adjustment for Trainees with Disability (TWD)**			
	Low Vision	**Deaf**	**Hard of hearing**	**Physical impairment**
Lecture discussion	❖ Provide large print text ❖ Prepare the lecture in **Audio/video** ❖ Organize the class room seating arrangement to be accessible to trainees ❖ Write short notes on the black/white board using large text ❖ Make sure the luminosity of the light of class room is kept ❖ Use normal tone of voice ❖ Encourage trainees to record the lecture in audio format ❖ Provide Orientation on the physical feature of the work shop ❖ Summarize main points	❖ Assign sign language interpreter ❖ Arrange the class room seating to be conducive for eye to eye contact ❖ Make sure the luminosity of the light of class room is kept ❖ Introduce new and relevant vocabularies ❖ Use short and clear sentences ❖ Give emphasis on visual lecture and ensure the attention of the trainees ❖ Avoid movement during lecture time ❖ Present the lecture in video format	❖Organize the class room seating arrangement to be accessible to trainees ❖Speak loudly ❖Ensure the attention of the trainees ❖Present the lecture in video format ❖Ensure the attention of the trainees	❖Organize the class room seating arrangement to be accessible for wheelchairs users. ❖ Facilitate and support the trainees who have severe impairments on their upper limbs to take note ❖ Provide Orientation on the physical feature of the work shop
		❖ Summarize main points		

Demonstration	❖ Conduct close follow up ❖ Use verbal description ❖ Provide special attention in the process of guidance ❖ facilitate the support of peer trainees ❖ Prepare & use simulation	❖ use Sign language interpreter ❖ Use video recorded material ❖ Ensure attention of the trainees ❖ Provide structured training ❖ Show clear and short method ❖ Use gesture ❖ provide tutorial support (if necessary)	❖ Illustrate in clear & short method ❖ Use Video recorded material ❖ Ensure the attention of the trainees ❖ provide tutorial support (if necessary)	❖ Facilitate and support the trainees having severe upper limbs impairment to operate equipment / machines ❖ Assign peer trainees to assist ❖ Conduct close follow up ❖ provide tutorial support (if necessary
Group discussion	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member ❖ Brief the thematic issues of the work	❖ Use sign language interpreters ❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Introduce the trainees with their peers

			❖ Inform the group members to speak loudly	
Exercise	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/practical training ❖ Introduce new and relevant vocabularies	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/ practical training	❖ Assign peer trainees ❖ Use additional nominal hours if necessary
Individual assignment	❖ prepare the assignment questions in large text ❖ Encourage the trainees to prepare and submit the assignment in large texts ❖ Make available recorded assignment questions ❖ Facilitate the trainees to prepare and submit the assignment in soft or hard copy	❖ Use sign language interpreter ❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	

ASSESSMENT METHODS:				
Interview		❖Use sign language interpreter ❖Ensure or conform whether the proper communication was conducted with the trainee through the service of the sign language interpreter ❖Use short and clear questioning ❖Time extension	❖Speak loudly ❖Using sign language interpreter if necessary	❖ Use written response as an option for the trainees having speech challenges
Written test	❖ Prepare the exam in large texts ❖ Use interview as an option if necessary ❖ Prepare the exam in audio format ❖ Assign human reader ❖ (if necessary) ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, True or False, matching and short answers ❖ Avoid essay writing ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, true or false, matching and short answers if necessary.	❖Use oral response as an option to give answer for trainees having severe upper limb impairment ❖Time extension for trainees having severe upper limb impairment
Demonstration /Observation	❖ Brief the instruction or provide them in large text	❖Use sign language interpreter ❖Brief on the instruction of the	❖Provide activity based assessment ❖Brief on the instruction of the exam	❖ Provide activity based assessment

	❖ Time extension	❖Provide activity-based/ practical assessment method ❖Time extension	❖ Use loud voice ❖ Time extension	❖Conduct close follow up ❖Time extension

ASSESSMENT CRITERIA:

LO1. Determine job requirements

- Drawings are interpreted to produce component to specifications.
- Sequence of operation is determined to produce component according to specification.
- Cutting tools, instruments and machine accessories are selected according to the requirements of the operation.
- Cutting speed and feeds rate are calculated based on work- piece and cutting tool material specifications
- Process/job/adjustment sheets are filled up with relevant machine, tool and raw material data due to standard

LO.2. Prepare CNC lathe machining process / Write program

- Coordinates are calculated for simple tool path machining functions based on part or product to be produced.
- Program is written in standard CNC lathe operations, code format and in accordance with standard operating procedures.
- Program is simulated and edited according to standard operating procedures.
- Program is documented and saved to the machine according to standard operating procedures.
- Program is downloaded to the machine according to standard operating procedures.

LO3. Perform appropriate Lathe operations

- Work-piece is mounted or set in accordance with standard operating procedures.
- Dry run is performed in accordance with the desired tool path movement.
- Advance CNC lathe operations are performed to produce component according to drawing specifications.
- Corrective measures/adjustments are performed if necessary due to standard
- Occupational health and safety are observed throughout the operation

LO4. Comply with Quality assurance

- Components are checked for conformance to specification using appropriate techniques and procedures.
- Deviations are handled appropriately in accordance with organization procedures and standard
- Product quality of the CNC production is compared with conventional production.

Annex: Resource Requirements

INDMAC3 M02 0322 Performing Advanced Lathe CNC Operations				
Item No.	**Category/Item**	**Description/ Specifications**	**Quantity**	**Recommended Ratio (Item: Trainee)**
A.	**Learning Materials**			
1.	TTLM	TTTLM prepared by Trainer	25	1:1
2.	Reference Books	- Computer Numerical Control Programming Basics Steve Krar Arthur Gill - FANUC Series oi MODEL F for lath system operational system B-64604EN-1/01 CNC 8055 M Examples manual REF. 1010 FAGOR AUTOMATION	5	1:5
B.	**Learning Facilities & Infrastructure**			
1.	Lecture Room	5m*10m	25	1:1
2.	Library	Standard	25	1:1
3.	Work shop	STD	1	1:5
C.	**Consumable Materials**			
1.	Paper	A4	1pac.	1:25
2.	Aluminum ingot	Dia.30-80x500mm	Each 5	1:5
3	Mild steel	Dia.20-50x6000mm	each1	1:25
4	CNC Lathe Cutter	HSS(12x12x200,25x25x200) Carbide tip Parting tool6x25x200	20 pcs	1:5
5	Machine oil coolant	Litter 32 viscosity	100	1:5
D.	**Tools and Equipment**			
1	Vernier caliper	Out, inside	5 pcs	1:5
2	Dial indicator	STD	5 pcs	1:5
3	Micrometer	In-out, depth	5 pcs	1:5
4	Steel ruler	STD	5 pcs	1:5
5	Digital calipers	STD	5 pcs	1:5

6	Gauges (thread, pin, depth, surface comparator, radius, screw pitch, slip or block, taper, plug, thickness)	STD	5 pcs	1:5
7	Thread gauge.	STD	5 pcs	1:5
8	Dead center.	STD	5 pcs	1:5
9	Live center.	STD	5 pcs	1:5
10	Follow rest, steady rest etc.	STD	5 pcs	1:5
11	LCD Projector	055-inch wide Panel (D7)	1Pcs	1:25
12	Turning tool	STD	5Packs	1;5
13	Threading tool	STD	5Packs	1;5
14	Parting tool	STD	5packs	1;5
15	CNC Machine	STD	5pcs	1:5

LEARNING MODULE 03
TVET-PROGRAMME TITLE: **Machining Level III**
MODULE TITLE: **Performing Advanced CNC Milling Operations**
MODULE CODE: **IND MAC3 M03 0322**
NOMINAL DURATION: **120 Hours**
MODULE DESCRIPTION: This module covers the knowledge, attitudes and skills needed to perform advanced CNC milling operations conforming to the required specifications. It includes manufacturing jigs and fixtures ,and press tools and die
LEARNING OUTCOMES At the end of the module the trainee will be able to: **LO1.** Determine job requirements **LO 2.** Write or load CNC milling machine program **LO 3.** Perform milling operations **LO 4.** Select materials **LO 5.** Produce and assemble components **LO 6.** Comply with Quality assurance

MODULE CONTENTS:

LO1. Determine job requirements

1.1. Interpreting drawings to produce components.

1.2. Determining Sequence of operation to produce component.

1.3. Selecting cutting tools.

1.4. Calculating cutting speed and feed rate

1.5. Filling up processing/job/adjustment sheets.

1.6. Determining and design jigs and fixture

1.7. Visualizing and interpreting jigs and fixtures.

1.8. Conceptualizing and planning tool and die type.

LO2. Write or load CNC milling machine program

2.1 Calculating Coordinates for simple and advanced tool path machining

2.2 Programing CNC milling operation written code format.

2.3 Simulating and editing Program.

2.4 Programing documented and saved to the machine.

2.5 Downloading the Program.

LO3. Perform milling operations

3.1 Mounting work piece with standard operating procedures.

3.2 Performing machine zero and work zero.

3.3 Performing dry run with the desired tool path movements.

3.4 Performing DNC with product type

3.5 Performing CNC milling operations to produce components.

3.5.1 Performing Corrective measures/adjustments

3.5.2 Replacement of cutting tools

3.5.3 Adjustment of tool offset

3.5.4 Adjustment of cutting speed and federate

3.6 Observing safety procedures and environmental protections.

3.7 Using Personal protective devices (OHS)

LO4 Select materials

4.1. Selecting appropriate materials jigs and fixtures.

4.2. Developing plan and sequence to perform manufacturing process.

4.3. Testing and selecting materials for hardness.

4.4. Planning and developing sequence of manufacturing process.

LO5. Produce and assemble components

2.1 Selecting machining process.

5.2. Selecting appropriate hand tools and handheld power tools.

5.3. Producing for testing practical prototype.

5.4. Selecting standardized jigs and fixture tool and die components.

5.5. Observing Occupational health and safety procedures.

Lo6 Comply with Quality assurance

1.1 Checking and measuring work piece.

1.2 Utilizing methods, measuring tools and equipment’s

1.3 Marketing, recording and reporting defective works.

1.4 Comparing product quality of CNC production .

Learning Methods:				
For none impaired trainees	**Reasonable Adjustment for Trainees with Disability (TWD)**			
	Low Vision	**Deaf**	**Hard of hearing**	**Physical impairment**
Lecture discussion	❖ Provide large print text ❖ Prepare the lecture in **Audio/video** ❖ Organize the class room seating arrangement to be accessible to trainees ❖ Write short notes on the black/white board using large text ❖ Make sure the luminosity of the light of class room is kept ❖ Use normal tone of voice ❖ Encourage trainees to record the lecture in audio format ❖ Provide Orientation on the physical feature of the work shop ❖ Summarize main points	❖ Assign sign language interpreter ❖ Arrange the class room seating to be conducive for eye to eye contact ❖ Make sure the luminosity of the light of class room is kept ❖ Introduce new and relevant vocabularies ❖ Use short and clear sentences ❖ Give emphasis on visual lecture and ensure the attention of the trainees ❖ Avoid movement during lecture time ❖ Present the lecture in video format	❖Organize the class room seating arrangement to be accessible to trainees ❖Speak loudly ❖Ensure the attention of the trainees ❖Present the lecture in video format ❖Ensure the attention of the trainees	❖Organize the class room seating arrangement to be accessible for wheelchairs users. ❖ Facilitate and support the trainees who have severe impairments on their upper limbs to take note ❖ Provide Orientation on the physical feature of the work shop
		❖ Summarize main points		

Demonstration	❖ Conduct close follow up ❖ Use verbal description ❖ Provide special attention in the process of guidance ❖ facilitate the support of peer trainees ❖ Prepare & use simulation	❖ use Sign language interpreter ❖ Use video recorded material ❖ Ensure attention of the trainees ❖ Provide structured training ❖ Show clear and short method ❖ Use gesture ❖ provide tutorial support (if necessary)	❖ Illustrate in clear & short method ❖ Use Video recorded material ❖ Ensure the attention of the trainees ❖ provide tutorial support (if necessary)	❖ Facilitate and support the trainees having severe upper limbs impairment to operate equipment / machines ❖ Assign peer trainees to assist ❖ Conduct close follow up ❖ provide tutorial support (if necessary
Group discussion	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member ❖ Brief the thematic issues of the work	❖ Use sign language interpreters ❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Introduce the trainees with their peers

			❖ Inform the group members to speak loudly	
Exercise	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/practical training ❖ Introduce new and relevant vocabularies	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/ practical training	❖ Assign peer trainees ❖ Use additional nominal hours if necessary
Individual assignment	❖ prepare the assignment questions in large text ❖ Encourage the trainees to prepare and submit the assignment in large texts ❖ Make available recorded assignment questions ❖ Facilitate the trainees to prepare and submit the assignment in soft or hard copy	❖ Use sign language interpreter ❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	

ASSESSMENT METHODS:				
Interview		❖Use sign language interpreter ❖Ensure or conform whether the proper communication was conducted with the trainee through the service of the sign language interpreter ❖Use short and clear questioning ❖Time extension	❖Speak loudly ❖Using sign language interpreter if necessary	❖ Use written response as an option for the trainees having speech challenges
Written test	❖ Prepare the exam in large texts ❖ Use interview as an option if necessary ❖ Prepare the exam in audio format ❖ Assign human reader ❖ (if necessary) ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, True or False, matching and short answers ❖ Avoid essay writing ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, true or false, matching and short answers if necessary.	❖Use oral response as an option to give answer for trainees having severe upper limb impairment ❖Time extension for trainees having severe upper limb impairment
Demonstration /Observation	❖ Brief the instruction or provide them in large text	❖Use sign language interpreter ❖Brief on the instruction of the	❖Provide activity based assessment ❖Brief on the instruction of the exam	❖ Provide activity based assessment

	❖ Time extension	❖Provide activity-based/ practical assessment method ❖Time extension	❖ Use loud voice ❖ Time extension	❖Conduct close follow up ❖Time extension

ASSESSMENT CRITERIA:

LO.1 Determine job requirements

- Drawings are interpreted to produce component to specifications.
- Sequence of operation is determined to produce component according to specification.
- Cutting tools are selected according to the requirements of the operation.
- Cutting speed and feed rate are calculated based on work piece and cutting tool material standard
- Process/job/adjustment sheets are filled up with relevant machine, tool and raw material data according to machine standard.
- Jigs and fixture requirements are determined type and design from customer's components drawings, prints or sample component
- Jigs and fixtures design is interpreted and visualized from type Jigs/fixtures drawings, prints or plan and checked against customer requirements
- Tool and die type and design are conceptualized and planned with reference to customer's specification.

LO.2 Write or load CNC milling machine program

- Coordinates are calculated for simple and advanced tool path machining functions based on part or product to be produced in accordance with standard
- Program is written in standard CNC milling operation code format and in accordance with standard operating 2D and 3D.procedures
- Program is simulated and edited according to standard operating procedures.
- Program is documented and saved to the machine according to standard operating procedures.
- Program is downloaded to the machine according to standard operating procedures (if required).

Lo3 Perform milling operations

- Work piece is mounted or set in accordance with standard operating procedures
- Machine zero and work zero are performed in accordance the standard
- Dry run is performed in accordance with the desired tool path movement
- DNC is performed in accordance with product type
- CNC milling operations are performed to produce component according to drawing specifications
- Corrective measures/adjustments are performed if necessary based on operational procedures
- Safety procedures and environmental protection are observed during machining operation
- Personal protective devices are used in accordance with Occupational Health and Safety (OHS) requirements throughout the process.

Lo4 Select materials

- Appropriate materials are selected and obtained to meet and jigs and fixtures tool and die requirements due to standards
- Comprehensive plan is developed to sequence and to perform manufacturing process requirements
- Selected materials are tested for hardness according to specifications
- Plan is developed to sequence and stage manufacturing process

Lo5 Produce and assemble components

- Appropriate machines and machining process are selected based on a range of standard/special tool room machines.
- Appropriate hand tools and handheld power tools are selected and used to manufacture jig and fixture, and tool and die components to specification.
- Where practical, prototype or section is produced for testing based on specifications
- Standardized jigs and fixture, and tool and die components are selected based on working drawing
- Occupational health and safety procedures and environmental protection guidelines are observed throughout the process

Lo6 Comply with Quality assurance

- Work piece is checked and measured in conformance to specification and quality output
- Appropriate methods, measuring tools and equipment are utilized throughout the operation with compliance to standards.
- Defective work pieces are marked, recorded and reported for proper action based on operational requirements
- Compare product quality of the CNC production with conventional production.

Annex: Resource Requirements

IND MAC3 M03 0322	Performing Advanced CNC Milling Operations			
Item No.	**Category/Item**	**Description/ Specifications**	**Quantity**	**Recommended Ratio (Item: Trainee)**
A.	**Learning Materials**			
1.	TTLM	TTTLM prepared by the trainer	25pc	1;1
2.	Text book	Any book related to the UC	5	1:5
3	Reference Books	- Computer Numerical Control Programming Basics Steve Krar Arthur Gill. - FANUC Series oi MODEL F for lath system operational system B-64604EN-1/01 CNC 8055 M Examples manual REF. 1010 FAGOR AUTOMATION	5	1:5
B.	**Learning Facilities & Infrastructure**			
1.	Class room	5m*10m	1	1:25
2.	lecture room	standard	1	1;25

C.	**Consumable Materials**			
1.	Paper	A4andA3	5pac	1;5
2.	White board marker	standard	1pac	--
3.	Aluminum Ingot	Ø50mmx500mm	25	1;1
4.	Oil	32,48,64 viscosity	25	1:1
5.	Coulant Oil		25	1:1
6.	Milling Cutter	Concave .convex ,Cylindrical, dick type ,End mill, Side milling cutter ,Gear cutter	1Pack each	1:5
D.	**Tools and Equipment's**			
1.	White board	standard	1	1;25
2.	LCD Projector	055-inch wide Panel (D7)	1Pcs	1:25
3.	CNC Milling Machine with accessories	2	1;1	1;12
4.				

LEARNING MODULE 04
IND MAC3 M 04 0322 Performing Advanced Grinding Operations
TVET-PROGRAMME TITLE: **Machining Level III**
MODULE TITLE: **Performing Advanced Grinding Operations**
MODULE CODE: **IND MAC3 M04 0322**
NOMINAL DURATION: **60 Hours**
MODULE DESCRIPTION: This module covers the knowledge, attitudes and skills needed to perform advanced CNC milling operations conforming to the required specifications. It includes manufacturing jigs and fixtures ,and press tools and die
LEARNING OUTCOMES At the end of the module the trainee will be able to: **LO1.** Set up work **LO2.** Perform advanced grinding operations **LO3 .**Perform tool and cutter grinding operation **LO4.** Check components for conformance to specifications

MODULE CONTENTS:

LO1. Set up work

1.1. Operating job requirements and sequences.

1.2. Selecting correct and appropriate work holding devices.

1.3. Selecting Grinding wheels by its type, form and sizes.

1.4. Selecting accessories to facilitate production tasks**.**

LO2. Perform advanced grinding operations

2.1 Adjusting and set up Grinding

2.2 Performing Grinding operations and following safely.

2.3 Performing grinding operations.

2.4 Observing measuring and procedures OHS

LO3.Perform tool and cutter grinding operation

3.1 Operating Tool grinding machines to sharpen and shape cutters.

3.2 caring out internal and/or external grinding

LO4 Check components for conformance to specifications

4.1. Checking Components using appropriate techniques, tools and equipment

4.2. Determining Required grade of tolerance is based on working drawing.

Learning Methods:				
For none impaired trainees	**Reasonable Adjustment for Trainees with Disability (TWD)**			
	Low Vision	**Deaf**	**Hard of hearing**	**Physical impairment**
Lecture discussion	❖ Provide large print text ❖ Prepare the lecture in **Audio/video** ❖ Organize the class room seating arrangement to be accessible to trainees ❖ Write short notes on the black/white board using large text ❖ Make sure the luminosity of the light of class room is kept ❖ Use normal tone of voice ❖ Encourage trainees to record the lecture in audio format ❖ Provide Orientation on the physical feature of the work shop ❖ Summarize main points	❖ Assign sign language interpreter ❖ Arrange the class room seating to be conducive for eye to eye contact ❖ Make sure the luminosity of the light of class room is kept ❖ Introduce new and relevant vocabularies ❖ Use short and clear sentences ❖ Give emphasis on visual lecture and ensure the attention of the trainees ❖ Avoid movement during lecture time ❖ Present the lecture in video format	❖Organize the class room seating arrangement to be accessible to trainees ❖Speak loudly ❖Ensure the attention of the trainees ❖Present the lecture in video format ❖Ensure the attention of the trainees	❖Organize the class room seating arrangement to be accessible for wheelchairs users. ❖ Facilitate and support the trainees who have severe impairments on their upper limbs to take note ❖ Provide Orientation on the physical feature of the work shop

		❖ Summarize main points		
Demonstration	❖ Conduct close follow up ❖ Use verbal description ❖ Provide special attention in the process of guidance ❖ facilitate the support of peer trainees ❖ Prepare & use simulation	❖ use Sign language interpreter ❖ Use video recorded material ❖ Ensure attention of the trainees ❖ Provide structured training ❖ Show clear and short method ❖ Use gesture ❖ provide tutorial support (if necessary)	❖ Illustrate in clear & short method ❖ Use Video recorded material ❖ Ensure the attention of the trainees ❖ provide tutorial support (if necessary)	❖Facilitate and support the trainees having severe upper limbs impairment to operate equipment / machines ❖Assign peer trainees to assist ❖Conduct close follow up ❖ provide tutorial support (if necessary
Group discussion	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member ❖ Brief the thematic issues of the work	❖ Use sign language interpreters ❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Introduce the trainees with their peers

			❖ Inform the group members to speak loudly	
Exercise	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/practical training ❖ Introduce new and relevant vocabularies	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/ practical training	❖ Assign peer trainees ❖ Use additional nominal hours if necessary
Individual assignment	❖ prepare the assignment questions in large text ❖ Encourage the trainees to prepare and submit the assignment in large texts ❖ Make available recorded assignment questions ❖ Facilitate the trainees to prepare and submit the assignment in soft or hard copy	❖ Use sign language interpreter ❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	

ASSESSMENT METHODS:				
Interview		❖Use sign language interpreter ❖Ensure or conform whether the proper communication was conducted with the trainee through the service of the sign language interpreter ❖Use short and clear questioning ❖Time extension	❖Speak loudly ❖Using sign language interpreter if necessary	❖ Use written response as an option for the trainees having speech challenges
Written test	❖ Prepare the exam in large texts ❖ Use interview as an option if necessary ❖ Prepare the exam in audio format ❖ Assign human reader ❖ (if necessary) ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, True or False, matching and short answers ❖ Avoid essay writing ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, true or false, matching and short answers if necessary.	❖Use oral response as an option to give answer for trainees having severe upper limb impairment ❖Time extension for trainees having severe upper limb impairment
Demonstration /Observation	❖ Brief the instruction or provide them in large text	❖Use sign language interpreter ❖Brief on the instruction of the	❖Provide activity based assessment ❖Brief on the instruction of the	❖ Provide activity based assessment

			exam	
	❖ Time extension	❖Provide activity-based/ practical assessment method ❖Time extension	❖ Use loud voice ❖ Time extension	❖Conduct close follow up ❖Time extension

ASSESSMENT CRITERIA:

LO.1 Set up work

- Job requirements and sequence of operations are determined based on specifications
- Correct and appropriate work holding devices are selected and applied according to machine type.
- Grinding wheels are selected by its type, form and size, checked if it has cracked or not, balanced and dressed with compliance to standard.
- Accessories are selected to facilitate production in accordance with task specifications.

LO.2 Perform advanced grinding operations

- Grinding machine is set up and adjusted in accordance with defined procedures.
- Grinding operations are performed safely, following all guards, safety procedures and personal protective clothing and equipment due to standard
- Specialized grinding operations are performed following the standards
- OHS measures and procedures are observed throughout the machining operations

Lo3 Perform tool and cutter grinding operation

- Tool grinding machines are operated to sharpen and shape the full range of tools and cutters due to requirements
- Parallel internal and/or external grinding is carried out in accordance with regulations

Lo4 4.Check components for conformance to specifications

- Components are checked for conformance to specification using appropriate techniques, tools and equipment
- Required grade of tolerance is determined based on working drawing Plan is developed to sequence and stage manufacturing process

Annex: Resource Requirements

IND MAC3 M04 0322 Performing Advanced Grinding Operations				
Item No.	**Category/Item**	**Description/ Specifications**	**Quantity**	**Recommended Ratio (Item: Trainee)**
A.	**Learning Materials**			
1.	TTLM	TTLM prepared by the trainer	25	1;1
2.	Reference Books	©2002 John Wiley & Sons, Inc. M. P. Groover, "Fundamentals of Modern Manufacturing 2/E"(Basic Machining Operation)		
B.	**Learning Facilities & Infrastructure**			
1.	Class room	5mm*10mm	25	1:5
2.	Work Shop room	standard	1	1:5
C.	**Consumable Materials**			
1.	Copy paper	Double A	1pack	1:5
2.	White board marker	standard	1pac	1;25
3.	Coolant Oil	Water soluble	25lit	1:5
4.	Dressing tools	STD	5	1:5
5.	Grinder Disc	Each type	5	1:5
6.	PPE Materials		25	1:1
D.	**Tools and Equipment's**			
1.	Surface, cylindrical, center less machines with their accessories	Standard	2	1;12
2.	Spanner	STP	5	1;5
3.	Wrench	STD	5	1;5

Learning Methods:				
For none impaired trainees	**Reasonable Adjustment for Trainees with Disability (TWD)**			
	Low Vision	**Deaf**	**Hard of hearing**	**Physical impairment**
Lecture discussion	❖ Provide large print text ❖ Prepare the lecture in **Audio/video** ❖ Organize the class room seating arrangement to be accessible to trainees ❖ Write short notes on the black/white board using large text ❖ Make sure the luminosity of the light of class room is kept ❖ Use normal tone of voice ❖ Encourage trainees to record the lecture in audio format ❖ Provide Orientation on the physical feature of the work shop ❖ Summarize main points	❖ Assign sign language interpreter ❖ Arrange the class room seating to be conducive for eye to eye contact ❖ Make sure the luminosity of the light of class room is kept ❖ Introduce new and relevant vocabularies ❖ Use short and clear sentences ❖ Give emphasis on visual lecture and ensure the attention of the trainees ❖ Avoid movement during lecture time ❖ Present the lecture in video format	❖Organize the class room seating arrangement to be accessible to trainees ❖Speak loudly ❖Ensure the attention of the trainees ❖Present the lecture in video format ❖Ensure the attention of the trainees	❖Organize the class room seating arrangement to be accessible for wheelchairs users. ❖ Facilitate and support the trainees who have severe impairments on their upper limbs to take note ❖ Provide Orientation on the physical feature of the work shop

		❖ Summarize main points		
Demonstration	❖ Conduct close follow up ❖ Use verbal description ❖ Provide special attention in the process of guidance ❖ facilitate the support of peer trainees ❖ Prepare & use simulation	❖ use Sign language interpreter ❖ Use video recorded material ❖ Ensure attention of the trainees ❖ Provide structured training ❖ Show clear and short method ❖ Use gesture ❖ provide tutorial support (if necessary)	❖ Illustrate in clear & short method ❖ Use Video recorded material ❖ Ensure the attention of the trainees ❖ provide tutorial support (if necessary)	❖ Facilitate and support the trainees having severe upper limbs impairment to operate equipment / machines ❖ Assign peer trainees to assist ❖ Conduct close follow up ❖ provide tutorial support (if necessary
Group discussion	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member ❖ Brief the thematic issues of the work	❖ Use sign language interpreters ❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Introduce the trainees with their peers

			❖ Inform the group members to speak loudly	
Exercise	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/practical training ❖ Introduce new and relevant vocabularies	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/ practical training	❖ Assign peer trainees ❖ Use additional nominal hours if necessary
Individual assignment	❖ prepare the assignment questions in large text ❖ Encourage the trainees to prepare and submit the assignment in large texts ❖ Make available recorded assignment questions ❖ Facilitate the trainees to prepare and submit the assignment in soft or	❖ Use sign language interpreter ❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	

	hard copy			
ASSESSMENT METHODS:				
Interview		❖Use sign language interpreter ❖Ensure or conform whether the proper communication was conducted with the trainee through the service of the sign language interpreter ❖Use short and clear questioning ❖Time extension	❖Speak loudly ❖Using sign language interpreter if necessary	❖ Use written response as an option for the trainees having speech challenges
Written test	❖ Prepare the exam in large texts ❖ Use interview as an option if necessary ❖ Prepare the exam in audio format ❖ Assign human reader ❖ (if necessary) ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, True or False, matching and short answers ❖ Avoid essay writing ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, true or false, matching and short answers if necessary.	❖Use oral response as an option to give answer for trainees having severe upper limb impairment ❖Time extension for trainees having severe upper limb impairment

Demonstration /Observation	❖ Brief the instruction or provide them in large text	❖Use sign language interpreter ❖Brief on the instruction of the	❖Provide activity based assessment ❖Brief on the instruction of the exam	❖ Provide activity based assessment
	❖ Time extension	❖Provide activity-based/ practical assessment method ❖Time extension	❖ Use loud voice ❖ Time extension	❖Conduct close follow up ❖Time extension

ASSESSMENT CRITERIA:

LO.1. Determine work requirements

- Drawings are interpreted, and sequence of operations is determined with accordance to standard
- Correct electrode is selected to ensure finished component conforms to drawing specifications.
- Electrode surface area is calculated and process parameters are set to give safe, accurate and efficient operation
- Comprehensive OHS procedures are observed

LO.2 Prepare EDM machining operations

- Accessories and work-holding fixtures are installed to ensure required position is obtained due to standard
- Machine and work piece is aligned to specified datum points in accordance with worksite standard procedures
- Program 2Delements and machine code functions are defined to meet specifications

LO.3 Perform electro-discharge machining (EDM)

- Electro-discharge machine is operated to produce components to drawing specifications
- Machine is cleaned and waste material disposed of in accordance with worksite procedures.

LO4. Check components for conformance to specification

- Components are checked using appropriate techniques, tools and equipment with conformance to specification
- Measurements are recorded in accordance with worksite procedures

Annex: Resource Requirements

IND MAC3 M05 0322 Performing EDM Plunger and Wire Operations				
Item No.	**Category/Item**	**Description/ Specifications**	**Quantity**	**Recommended Ratio (Item: Trainee)**
A.	**Learning Materials**			
1.	TTLM	TTTLM prepared by the trainer	25	1:1
2.	Reference Books	• EDM text book Jameson 2001.p.1 • EDM text Lazarenko B.R	5	1:5
4.	Journals/Publication/Magazines			
B.	**Learning Facilities & Infrastructure**			
1.	Lecture Room	Standard	1	1:25
2.	Clinic	Standard	1	1:25
C.	**Consumable Materials**			
1.	Copy paper drawing paper	A4,	5packs	1:5
2.	Wire electrode material	STD	1 roll	1:1
3.	Dielectric fluids	STD	25lits	1:1
D	**Tools and Equipment**			
1	Electrode Blank	STD	5pcs	1:5
2	EDM Jigs and Fixture	STD	5pcs	1:5
3	Electrode wire	STD	5pcs	1:5
4	Lone replacement Resin	STD	5pcs	1:5
5	Parts for wire cut	STD	5pcs	1:5
7	Sinker EDM Filters	STD	5pcs	1:5
8	Wire cut EDM Filters	STD	5pcs	1:5

LEARNING MODULE 06
TVET-PROGRAMME TITLE: **Machining LEVEL III**
MODULE TITLE : **Performing Advanced Press Operations**
MODULE CODE : **IND MAC3 M06 0322**
NOMINAL DURATION : **40 Hours**
MODULE DESCRIPTION: This Module covers the knowledge, attitudes and skills competence required in performing advanced press operations, recognizing and rectifying deviations and faults in the product/ output, raw material or feed stock.

LEARNING OUTCOMES

At the end of the module the trainee will be able to:

LO1. Determine job requirements

LO2. Prepare and perform press machine for operation

LO3. Fit die and mould parts

LO4. Set-up mould and moulding machines

LO5. Operate mould and press machines

LO6. Monitor machine/process

LO7. Assure quality outcomes

MODULE CONTENTS:

LO1. Determine job requirements

1.1 Interpreting drawings.

1.2 Identifying tools and equipment

1.3 Interpreting Assembly drawings to be fitted with another part.

1.4 Identifying fitting tools and equipment.

1.4.1 Center punch

1.4.2 Parallel clamps

1.4.3 Set of twist drills

1.4.4 Hand taps

1.4.5 Counter bore

1.4.6 Portable electric

LO2. Prepare and perform press machine for operation

2.1 Undertaking pre-start checks

2.2 Checking Safety equipment

2.3 Verifying and setting up equipment, raw material and tooling.

2.4 Operating machine/process.

2.5 Handling and storing machine/process output.

2.6 Recording production data.

2.7 Checking press and moulding machines for suitability to shut height.

2.8 Striping or blanking material cut to required size. or width and grain orientation.

2.9 Checking plastic and rubber raw materials.

2.6.1 Low carbon steel, Silicon steel, brass, copper

2.6.2 Blank/Plastic raw material may include: Strip & Single blank material

2.10 Inserting die set on the lower bolster plate and punch shank.

2.11 Adjusting press ram.

2.12 Operating press manually.

LO3. Fit die and mould parts

3.1 Manufacturing die and mould holes.

3.2 Fitting strippers plate openings with die.

3.3 Fitting cavity and core holding plates.

LO4. Set-up mould and moulding machines

4.1 Clamping half of mould to moving side of machine.

4.2 Clamping and checking fixed side of mould alignments.

4.3 Adjusting maximum mould opening.

4.4 Adjusting cycle time and temperature

4.5 Cycle time and temperature are adjusted to requirements

LO5. Operate mould and press machines

4.1 Operating moulding machine.

4.2 Pressing machine operations safely and correctly.

4.3 Loading material and the press tripped.

LO6. Monitor machine/process

6.1 Fitting the stripping /ejection mechanism

6.2 Monitoring machine/work processes.

6.3 Understanding and following emergency procedures

LO7. Assure quality outcomes

7.1 Recognizing and rectifying product and material faults/deviations.

7.2 Identifying workplace problems.

7.3 Pursuing product end control.

Learning Methods:				
For none impaired trainees	**Reasonable Adjustment for Trainees with Disability (TWD)**			
	Low Vision	**Deaf**	**Hard of hearing**	**Physical impairment**
Lecture discussion	❖ Provide large print text ❖ Prepare the lecture in **Audio/video** ❖ Organize the class room seating arrangement to be accessible to trainees ❖ Write short notes on the black/white board using large text ❖ Make sure the luminosity of the light of class room is kept ❖ Use normal tone of voice ❖ Encourage trainees to record the lecture in audio format ❖ Provide Orientation on the physical feature of the work shop ❖ Summarize main points	❖ Assign sign language interpreter ❖ Arrange the class room seating to be conducive for eye to eye contact ❖ Make sure the luminosity of the light of class room is kept ❖ Introduce new and relevant vocabularies ❖ Use short and clear sentences ❖ Give emphasis on visual lecture and ensure the attention of the trainees ❖ Avoid movement during lecture time ❖ Present the lecture in video format	❖Organize the class room seating arrangement to be accessible to trainees ❖Speak loudly ❖Ensure the attention of the trainees ❖Present the lecture in video format ❖Ensure the attention of the trainees	❖Organize the class room seating arrangement to be accessible for wheelchairs users. ❖ Facilitate and support the trainees who have severe impairments on their upper limbs to take note ❖ Provide Orientation on the physical feature of the work shop

		❖ Summarize main points		
Demonstration	❖ Conduct close follow up ❖ Use verbal description ❖ Provide special attention in the process of guidance ❖ facilitate the support of peer trainees ❖ Prepare & use simulation	❖ use Sign language interpreter ❖ Use video recorded material ❖ Ensure attention of the trainees ❖ Provide structured training ❖ Show clear and short method ❖ Use gesture ❖ provide tutorial support (if necessary)	❖ Illustrate in clear & short method ❖ Use Video recorded material ❖ Ensure the attention of the trainees ❖ provide tutorial support (if necessary)	❖ Facilitate and support the trainees having severe upper limbs impairment to operate equipment / machines ❖ Assign peer trainees to assist ❖ Conduct close follow up ❖ provide tutorial support (if necessary
Group discussion	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member ❖ Brief the thematic issues of the work	❖ Use sign language interpreters ❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Introduce the trainees with their peers

			❖ Inform the group members to speak loudly	
Exercise	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/practical training ❖ Introduce new and relevant vocabularies	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/ practical training	❖ Assign peer trainees ❖ Use additional nominal hours if necessary
Individual assignment	❖ prepare the assignment questions in large text ❖ Encourage the trainees to prepare and submit the assignment in large texts ❖ Make available recorded assignment questions ❖ Facilitate the trainees to prepare and submit the assignment in soft or hard copy	❖ Use sign language interpreter ❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	

ASSESSMENT METHODS:				
Interview		❖Use sign language interpreter ❖Ensure or conform whether the proper communication was conducted with the trainee through the service of the sign language interpreter ❖Use short and clear questioning ❖Time extension	❖Speak loudly ❖Using sign language interpreter if necessary	❖ Use written response as an option for the trainees having speech challenges
Written test	❖ Prepare the exam in large texts ❖ Use interview as an option if necessary ❖ Prepare the exam in audio format ❖ Assign human reader ❖ (if necessary) ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, True or False, matching and short answers ❖ Avoid essay writing ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, true or false, matching and short answers if necessary.	❖Use oral response as an option to give answer for trainees having severe upper limb impairment ❖Time extension for trainees having severe upper limb impairment
Demonstration /Observation	❖ Brief the instruction or provide them in large text	❖Use sign language interpreter ❖Brief on the instruction of the	❖Provide activity based assessment ❖Brief on the instruction of the exam	❖ Provide activity based assessment
	❖ Time extension	❖Provide activity-based/ practical assessment method ❖Time extension	❖ Use loud voice ❖ Time extension	❖Conduct close follow up ❖Time extension

ASSESSMENT CRITERIA:

LO1. Determine job requirements

- Drawings, work instructions and specifications are interpreted and task is understood including press machine/process selection and settings due to requirements
- Tools and equipment are identified according to press requirements.
- Assembly drawings are interpreted to determine which part to be fitted with another part based on standards
- Fitting tools and equipment are identified according to fitting requirements.

LO2. Prepare and perform press machine for operation

- Pre-start checks are undertaken to standard operating procedures
- Safety equipment and guards are checked for correct position and operation based on regulations
- Equipment, raw material and tooling are verified and set up to match task requirement
- Machine/process is operated in accordance with job instructions or standard operating procedures.
- Machine/process output is handled and stored in a manner not likely to cause damage, based on requirements
- Production data is recorded to standard operating procedures
- Press and moulding machines are checked for suitability to shut height based on machine specification
- Material is strip or blank cut to required size or width and grain orientation due to specifications
- Plastic and rubber raw materials are checked, as required
- Die set on the lower bolster plate and punch shank are inserted into ram-hole and tightened due to operational procedures
- Press ram is adjusted to bottom dead center with the punch end to the required punch setting.
- Press is operated manually to check position of punch due to operational procedures

LO3. Fit die and mould parts

- Die and mould holes are manufactured to template size and required angle clearance

- Stripper plate openings are fitted with die according to work specification
- Cavity and core holding plates are fitted with cavities according to work specification
- Core cavity holder plates are fitted to bottom bolster plate according to work specification

LO4. Set-up mould and moulding machines

- Moving half of mould is clamped to moving side of machine, ejector system adjusted to eject product based on operational procedures
- Fixed side of mould is clamped to fixed side of machine checking alignment based on machine operations
- Maximum mould opening is adjusted based on machine operation
- Cycle time and temperature are adjusted to requirements

LO5. Operate mould and press machines

- Moulding machine is operated according to standard procedure.
- Started up is pressed safely and correctly according to machine operations
- Material is loaded and the press tripped for sample product according to machine operations

LO6. Monitor machine/process

- Stripping/ejection mechanism fitted according to work specification
- Machine/work processes are monitored for safe and correct operation
- Emergency procedures are understood and followed in accordance with standard operating proceduresLO7. Assure quality outcomes
- Recognizing and rectifying product and material faults/deviations.
- Identifying workplace problems.
- Pursuing product end control against standards and specification and documented

LO7. Assure quality outcomes

- Product and material faults/deviations are recognized and rectified in accordance with all standard operating procedures
- Workplace problems are promptly identified and considered from an operational and customer service perspective
- Product end control is pursued against standards and specification and documented

Annex: Resource Requirements

IND MAC3 M06 0322 Performing Advanced Press Operations				
Item No.	**Category/Item**	**Description/ Specifications**	**Quantity**	**Recommended Ratio (Item: Trainee)**
A.	**Learning Materials**			
1.	TTLM	TTTLM prepared by Trainer	25	1:1
2.	Reference Books	El – Hoffy : Advance Machining Process, Mc Graw Hill Companies, 0.007-1466940, 2005	5	1:5
B.	**Learning Facilities & Infrastructure**			
1.	Class room	Standard	1	1:25
2.	Clinic	Standard	1	1:25
3.	Workshop	Standard	1	1:25
4.	Library	Standard	1	1:25
C.	**Consumable Materials**	Standard	25	1:1
3.	Paper	A4 & A3	5 pack	1:5
4.	White board marker	Standard	1 pack	---
5.	Aluminum Ingot	Ø 30-100x500mm	1 each	25
6.	Mild steel Round bar	Ø20-60x6000mm	1 each	25
D.	**Tools and Equipment**			
1.	Set of files	Standard	Each set 5	5:25
2.	Hand Drill Machine	Standard	5	1:5
3.	Different type of pressing machines with accessories	Standard	1each	1:25
4.	Personal protective equipment's	Standard	25	1:1
5.	Angle plate	STD	5	1:5
6.	Steel rule	30,50,60 and 100mm	25	1:1
7.	Vernier height gage	STD	2	1:12
8.	Vernier caliper	0.02,0.05 and 0.1mm	5	1:5
9.	Set of twist drills	STD	5	1:5
10.	Allen wrench	STD	5	1:5
11.	Parallel set	STD	5	1:5
12.	Center punch	STD	5	1:5
13.	Vise with soft jaws	STD	5	1:5
14.	Scribers	STD	5	1:5
15.	Hand tap	STD	5	1:5
16.	Counter bore	STD	5	1:5

LEARNING MODULE 07
TVET-PROGRAMME TITLE: **Machining Level III**
MODULE TITLE: **Performing Advanced Lathe Operations**
MODULE CODE: **IND MAC3 M07 0322**
NOMINAL DURATION:**100 Hours**
MODULE DESCRIPTION: This module covers the skill, knowledge and attitude required to turn work-piece to drawing specifications. It details the requirements for performing lathe operations such as machining components using steady rest, follower rest; cutting contours, eccentric turning, and, ACME (internal and external) and multi-start threads.
LEARNING OUTCOMES At the end of the module the trainee will be able to: **LO1.** Determine job requirements **LO2.** Setup work-piece **LO3.** Perform lathe operations **LO4.** Check/Measure work piece

MODULE CONTENTS:

LO1.Determine work requirements

1.1 Interpreting drawings.

1.2 Determining Sequence of operation.

1.3 Selecting cutting tools.

LO2. Setup work-piece

2.1 Mounting and Centering work-piece instruments/equipment

2.2 Performing setup operations

2.2.1 Surface gage

2.2.2 Dial indicator on magnetic stand

LO3. Perform lathe operations

3.1 Calculating speeds and feeds.

3.2 Appropriating lathe accessories used

3.3 Performing lathe operations

3.4 Performing safety procedures and personal protective devices.

LO4. Check/Measure work piece

4.1 Checking / Measuring work piece, measuring tools and equipment.

4.2 Checking work piece.

4.3 Handling deviations

Learning Methods:				
For none impaired trainees	**Reasonable Adjustment for Trainees with Disability (TWD)**			
	Low Vision	**Deaf**	**Hard of hearing**	**Physical impairment**
Lecture discussion	❖ Provide large print text ❖ Prepare the lecture in **Audio/video** ❖ Organize the class room seating arrangement to be accessible to trainees ❖ Write short notes on the black/white board using large text ❖ Make sure the luminosity of the light of class room is kept ❖ Use normal tone of voice ❖ Encourage trainees to record the lecture in audio format ❖ Provide Orientation on the physical feature of the work shop ❖ Summarize main points	❖ Assign sign language interpreter ❖ Arrange the class room seating to be conducive for eye to eye contact ❖ Make sure the luminosity of the light of class room is kept ❖ Introduce new and relevant vocabularies ❖ Use short and clear sentences ❖ Give emphasis on visual lecture and ensure the attention of the trainees ❖ Avoid movement during lecture time ❖ Present the lecture in video format	❖Organize the class room seating arrangement to be accessible to trainees ❖Speak loudly ❖Ensure the attention of the trainees ❖Present the lecture in video format ❖Ensure the attention of the trainees	❖ Organize the class room seating arrangement to be accessible for wheelchairs users. ❖ Facilitate and support the trainees who have severe impairments on their upper limbs to take note ❖ Provide Orientation on the physical feature of the work shop

		❖ Summarize main points		
Demonstration	❖ Conduct close follow up ❖ Use verbal description ❖ Provide special attention in the process of guidance ❖ facilitate the support of peer trainees ❖ Prepare & use simulation	❖ use Sign language interpreter ❖ Use video recorded material ❖ Ensure attention of the trainees ❖ Provide structured training ❖ Show clear and short method ❖ Use gesture ❖ provide tutorial support (if necessary)	❖ Illustrate in clear & short method ❖ Use Video recorded material ❖ Ensure the attention of the trainees ❖ provide tutorial support (if necessary)	❖ Facilitate and support the trainees having severe upper limbs impairment to operate equipment / machines ❖ Assign peer trainees to assist ❖ Conduct close follow up ❖ provide tutorial support (if necessary
Group discussion	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member ❖ Brief the thematic issues of the work	❖ Use sign language interpreters ❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Introduce the trainees with their peers

			❖ Inform the group members to speak loudly	
Exercise	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/practical training ❖ Introduce new and relevant vocabularies	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/ practical training	❖ Assign peer trainees ❖ Use additional nominal hours if necessary
Individual assignment	❖ prepare the assignment questions in large text ❖ Encourage the trainees to prepare and submit the assignment in large texts ❖ Make available recorded assignment questions ❖ Facilitate the trainees to prepare and submit the assignment in soft or hard copy	❖ Use sign language interpreter ❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	

ASSESSMENT METHODS:				
Interview		❖Use sign language interpreter ❖Ensure or conform whether the proper communication was conducted with the trainee through the service of the sign language interpreter ❖Use short and clear questioning ❖Time extension	❖Speak loudly ❖Using sign language interpreter if necessary	❖ Use written response as an option for the trainees having speech challenges
Written test	❖ Prepare the exam in large texts ❖ Use interview as an option if necessary ❖ Prepare the exam in audio format ❖ Assign human reader ❖ (if necessary) ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, True or False, matching and short answers ❖ Avoid essay writing ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, true or false, matching and short answers if necessary.	❖Use oral response as an option to give answer for trainees having severe upper limb impairment ❖Time extension for trainees having severe upper limb impairment
Demonstration /Observation	❖ Brief the instruction or provide them in large text	❖Use sign language interpreter ❖Brief on the instruction of the	❖Provide activity based assessment ❖Brief on the instruction of the	❖ Provide activity based assessment

			exam	
	❖ Time extension	❖Provide activity-based/ practical assessment method ❖Time extension	❖ Use loud voice ❖ Time extension	❖Conduct close follow up ❖Time extension

ASSESSMENT CRITERIA:

LO.1. Determine job requirements

1.1 Drawings are interpreted to produce component to specifications.

1.2 Sequence of operation is determined to produce component to specifications.

1.3 Cutting tools are selected according to the requirements of the operation.

LO.2 Setup work-piece

2.1 Work-piece is mounted and centered in chuck to required level of accuracy using instruments/equipment in accordance with worksite procedures.

2.2 Setup operations are performed applying safety procedures and using personal protective devices.

LO.3 Perform lathe operations

3.1 Speeds and feeds are calculated using appropriate mathematical techniques and reference material.

3.2 Lathe accessories used are appropriate to the requirements of the operation.

3.3 Lathe operations are performed to produce component to specifications in the drawing.

3.4 Operations are performed applying safety procedures and using personal protective devices.

LO4. Check/Measure work piece

3.1 Work piece is checked / measured for conformance to specification using appropriate techniques, measuring tools and equipment.

3.2 Work piece is checked for conformance with quality of finish.

3.3 Deviations are handled appropriately in accordance with organization procedures and standard.

Annex: Resource Requirements

IND MAC2 M07 0322 Performing Advanced Lathe Operation				
Item No.	**Category/Item**	**Description/ Specifications**	**Quantity**	**Recommended Ratio (Item: Trainee)**
A.	**Learning Materials**			
1.	TTLM	TTTLM prepared by the trainer	25	1:1
32	Reference Books	MODERN MACHINING TECHNOLOGY OPERATION APRACTICAL GUIDE EDDITED BY J PAULO DAVID	5	1:5
B.	**Learning Facilities & Infrastructure**			
1.	Drawing Room	Standard	1	1:25
2.	Clinic	Standard	1	1:25
C.	**Consumable Materials**			
1.	Copy paper drawing paper	A_4, A3	5packs	1:5
2.	Aluminum bar	500mmx ø 100mm	25pcs	1:1
3.	Aluminum bar	500mmx ø 50mm	25pcs	1:1
4.	Aluminum bar	500mmx ø 40mm	25pcs	1:1
5.	White Board Marker	Standard	1 pack	
6.	Mild steel round bar	6000mmx ø 100mm	25 pcs	1:1
7.	Mild steel round bar	6000mmx ø 70mm	1 pcs	1;25
8.	Mild steel round bar	6000mmx ø 50mm	1 pcs	1:25
9.	Mild steel round bar	6000mmx ø 30mm	5 pcs	1:5
10.	Mild steel round bar	6000mmx ø 20mm	5 pcs	1:5
11.	Mild steel round bar	6000mmx ø 12mm	5pcs	1:5
12.	Different power hacksaw blade	Sweden	25 pcs	1:1
13.	Drill bit(different size)	Set ø1-13	2 pcs	1:12
14.	Grinder wheel disc	set	2 pcs	1:12
15.	Machine coolant	Standard	20 liter	1:5

17	Cutter	HSS(12 x 12)(25 x25) x 200	2pac each	1:25
18	Machine oil	32, 48, 64, viscosity	20 l	
D	**Tools and Equipment**			
1	White Board	Standard	1	1:25
2	Micrometer	(0 -25),(25-50)(50-75),(75-100)	5	1:5
3	Vernier caliper	out, inside	5	1:5
4	Dial gauge with mag	std.	5	1:5
5	Try-square and Protractor	30^0 X 60^0	5	1:5
6	Combination gauge	Standard	5	1:5
7	Steel rule	50cm,100cm	25	1:1
8	LCD	Standard	1	1:25
9	Scriber	Standard	25 pcs	1:1
10	Bevel protractor	Standard	5 pcs	1:5
11	Bench vise	Standard	25 pcs	1:1
12	Surface plate	Standard	2 pcs	2:25
13	Pedestal Grinder	Standard	2 pcs	2:12
14	Knurling tools	Medium size	2 pcs	2:12
15	Lathe machine with accessories	Standard	5 pcs	5:25

LEARNING MODULE 08
TVET-PROGRAMME TITLE: **Machining LEVEL III**
MODULE TITLE : **Perform Advanced Milling Operations**
MODULE CODE : **INDMAC3 M08 0322**
NOMINAL DURATION : **100 Hours**
MODULE DESCRIPTION: This module covers the knowledge, skills and attitudes required to setup and mill work piece to drawing specifications. It details the requirements for performing milling operations using differential indexing and performing spiral milling which are considered as 'advanced' milling operations.
LEARNING OUTCOMES At the end of the module the trainee will be able to: **LO1.** Determine job requirements **LO2.** Set-up work piece **LO3.** Perform milling operations **LO4.** Check/ Measure work piece

MODULE CONTENTS:

LO1. Determine job requirements

1.1 Interpreting drawings

1.2 Determining sequence of operation.

1.3 Selecting cutting tools**.**

LO2. Set-up work piece

2.1 Setting up work pieces.

2.2 .Performing setup operations.

LO3. Perform milling operations

3.1 Setting Speeds and feeds.

3.2 Using milling machine accessories.

3.3 Performing milling operations.

3.4 Applying OHS

LO4. Check/ Measure work piece

6.1 Checking / measuring work piece.

6.2 Checking work piece for conformance with quality of finish.

6.3 Handling deviations.

Learning Methods:				
For none impaired trainees	**Reasonable Adjustment for Trainees with Disability (TWD)**			
	Low Vision	**Deaf**	**Hard of hearing**	**Physical impairment**
Lecture discussion	❖ Provide large print text ❖ Prepare the lecture in **Audio/video** ❖ Organize the class room seating arrangement to be accessible to trainees ❖ Write short notes on the black/white board using large text ❖ Make sure the luminosity of the light of class room is kept ❖ Use normal tone of voice ❖ Encourage trainees to record the lecture in audio format ❖ Provide Orientation on the physical feature of the work shop ❖ Summarize main points	❖ Assign sign language interpreter ❖ Arrange the class room seating to be conducive for eye to eye contact ❖ Make sure the luminosity of the light of class room is kept ❖ Introduce new and relevant vocabularies ❖ Use short and clear sentences ❖ Give emphasis on visual lecture and ensure the attention of the trainees ❖ Avoid movement during lecture time ❖ Present the lecture in video format	❖Organize the class room seating arrangement to be accessible to trainees ❖Speak loudly ❖Ensure the attention of the trainees ❖Present the lecture in video format ❖Ensure the attention of the trainees	❖ Organize the class room seating arrangement to be accessible for wheelchairs users. ❖ Facilitate and support the trainees who have severe impairments on their upper limbs to take note ❖ Provide Orientation on the physical feature of the work shop

		❖ Summarize main points		
Demonstration	❖ Conduct close follow up ❖ Use verbal description ❖ Provide special attention in the process of guidance ❖ facilitate the support of peer trainees ❖ Prepare & use simulation	❖ use Sign language interpreter ❖ Use video recorded material ❖ Ensure attention of the trainees ❖ Provide structured training ❖ Show clear and short method ❖ Use gesture ❖ provide tutorial support (if necessary)	❖ Illustrate in clear & short method ❖ Use Video recorded material ❖ Ensure the attention of the trainees ❖ provide tutorial support (if necessary)	❖ Facilitate and support the trainees having severe upper limbs impairment to operate equipment / machines ❖ Assign peer trainees to assist ❖ Conduct close follow up ❖ provide tutorial support (if necessary
Group discussion	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member ❖ Brief the thematic issues of the work	❖ Use sign language interpreters ❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Facilitate the integration of trainees with group members ❖ Conduct close follow up ❖ Introduce the trainees with other group member	❖ Introduce the trainees with their peers

			❖ Inform the group members to speak loudly	
Exercise	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/practical training ❖ Introduce new and relevant vocabularies	❖ Conduct close follow up and guidance ❖ Provide tutorial support if necessary ❖ provide special attention in the process/ practical training	❖ Assign peer trainees ❖ Use additional nominal hours if necessary
Individual assignment	❖ prepare the assignment questions in large text ❖ Encourage the trainees to prepare and submit the assignment in large texts ❖ Make available recorded assignment questions ❖ Facilitate the trainees to prepare and submit the assignment in soft or hard copy	❖ Use sign language interpreter ❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	❖ Provide briefing /orientation on the assignment ❖ Provide visual recorded material	

ASSESSMENT METHODS:				
Interview		❖Use sign language interpreter ❖Ensure or conform whether the proper communication was conducted with the trainee through the service of the sign language interpreter ❖Use short and clear questioning ❖Time extension	❖Speak loudly ❖Using sign language interpreter if necessary	❖ Use written response as an option for the trainees having speech challenges
Written test	❖ Prepare the exam in large texts ❖ Use interview as an option if necessary ❖ Prepare the exam in audio format ❖ Assign human reader ❖ (if necessary) ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, True or False, matching and short answers ❖ Avoid essay writing ❖ Time extension	❖ Prepare the exam using short sentences, multiple choices, true or false, matching and short answers if necessary.	❖Use oral response as an option to give answer for trainees having severe upper limb impairment ❖Time extension for trainees having severe upper limb impairment
Demonstration /Observation	❖ Brief the instruction or provide them in large text	❖Use sign language interpreter ❖Brief on the instruction of the	❖Provide activity based assessment ❖Brief on the instruction of the	❖ Provide activity based assessment

			exam	
	❖ Time extension	❖Provide activity-based/ practical assessment method ❖Time extension	❖ Use loud voice ❖ Time extension	❖Conduct close follow up ❖Time extension

ASSESSMENT CRITERIA:

LO1. Determine job requirements

- Drawings are interpreted to produce component to specifications.
- Sequence of operation is determined to produce component to specifications.
- Cutting tools are selected according to the requirements of the operation.

LO.2. Set-up work piece

- Work pieces setup to required level of accuracy using instruments/equipment according to work site procedures.
- Setup operations are performed applying safety procedures and using personal protective devices.

LO3. Perform milling operations

- Speeds and feeds are set appropriate to the job.
- Milling machine accessories used are appropriate to the requirements of the operation.
- Milling operations are performed to produce component to specifications in the drawing.
- Milling operations are performed applying knowledge on safety procedures and using personal protective devices.

LO4. Check/ Measure work piece

- Work piece is checked / measured for conformance to specification using appropriate techniques, measuring tools and equipment.
- Work piece is checked for conformance with quality of finish.
- Deviations are handled appropriately in accordance with organization procedures and standard.

Annex: Resource Requirements

IND MAC3 M08 0322 Performing Advanced Milling Operations				
Item No.	**Category/Item**	**Description/ Specifications**	**Quantity**	**Recommended Ratio (Item: Trainee)**
A.	**Learning Materials**			
1.	TTLM	TTTLM prepared by Trainer	25	1:1
2.	Text book	Any book related to the subject	5	1:5
3.	Reference Books	• **Metal Cutting Principles Second Edition Milton C. Shaw** • Serope Kalpakjian And Steven R. Schmid-Manufacturing Engineering And Technology-6th Edition	5	1:5
B.	**Learning Facilities & Infrastructure**			
1.	Lecture Room	Standard	25	1:1
2.	Library	Standard	25	1:1
3.	Work shop	Standard	25	1:1
C.	**Consumable Materials**			
1.	Paper	A4	1pac.	1:25
2.	Aluminum ingot	Dia.30-80x500mm	Each 5	1:5
3	mild steel	Dia.20-50x6000mm	each1	1:25
7	Milling Module Cutter	STD	8Set	8:25
8	Concave and convex type	STD	5 Set	1:5
9	Side milling cutter	STD	5 Set	1:5
10	Face milling cutter	STD	5 Set	1:5
11	T-Slot cutter	STD	5 Set	1:5
12	End mill cutter	STD	5 Set	1:5
5	Machine oil coolant	Litter 32 viscosity	100	1:5
D.	**Tools and Equipment**			
1	Vernier caliper	Out, inside	5 pcs	1:5
2	Dial indicator	STD	5 pcs	1:5
3	Micrometer	In-out, depth	5 pcs	1:5
4	Steel ruler	STD	5 pcs	1:5
5	Digital calipers	STD	5 pcs	1:5

6	Gauges (thread, pin, depth, surface comparator, radius, screw pitch, slip or block, taper, plug, thickness)	STD	5 pcs	1:5

Acknowledgement

The **Ministry of Labor and Skills and Federal TVET Institute (FTI)** wishes to thank and appreciation for the trainers who donated their effort and time to develop this outcome based curriculum for the TVET program machining LEVEL III. We also thank all regional TVET College, management institute at bishoftu programmers for active facilitation of their trainers for the development of this curriculum.

The trainers who developed the curriculum

No	Name	Qualification	Educational background	Region	College	Mobile number	E-mail
1	SISAY MINDA BIRKE	M.Sc. In Manufacturing Technology	A LEVEL	Dire Dawa	Ethio-Italy Poly Technic College	09-21-19-76-80	Sisayminda34@gmail.com
2	MULUNEH NEGUSE DAMITEW	M.Sc. In Manufacturing Technology	A LEVEL	Amhara	Combolcha Poly Technic Collen	09-32-28-95-28	Muluneh3000@gmail.com
3	ANTENEH GETACHEW ASSEFA	M.Sc. In Manufacturing Technology	B LEVEL	Addis Ababa	Nefassilk Poly Technic College	09-13-47-97-52	
4	HAFTOM AWEKE HAFTIMIER	M.Sc. In Mechanical Engineering	A LEVEL	Addis Ababa	ETU	09-21-43-82-07	Haftom.aweke@gmail.com
5	TESHOME W/YOHANES ELEMA	M.Sc. In Manufacturing Technology	A LEVEL	Awassa	Awassa Poly Technic College	09-16-31-21-42	Tesho1921@gmail.com