



COMPETENCY BASED CURRICULUM (DIGITAL FABRICATION)

BQF CERTIFICATE 3



Published by

Technical Trainers Training and Resource Center
Department of Workforce Planning and Skills Development
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Department of Workforce Planning and Skills Development

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FOREWORD

Bhutan has seen a gradual increase in the requirement of skilled workers in recent years due to growth of industries. However, supply of skilled workforce that are responsive to the needs of the industry has not been able to keep in pace with the industry demand. Since skilled workers are crucial ingredient for socio-economic development of the country, it is important to have adequate number of trained and certified workers. With growing industries, the “Digital Fabrication Technician” is not only the most significant occupation but also have high demand in the labour market. In an effort to meet the skilled human resources requirement in the area of power sector, it is imperative to deliver training based on Competency Based Training system in Digital Fabrication BQF Certificate-3 to ensure quality and adequate number of work force in this sector.

To this end, the Department of Workforce Planning and Skills Development (DWPSD) is pleased to present first edition of Competency Based Curriculum for Digital Fabrication BQF Certificate 3 course developed based on national competency standards. Since it is an outcome of a more participatory process of curriculum development, it is expected to provide training delivery with reformed approaches having its content being directly related to labour market needs, focusing on imparting of skills and assessment based on industry work standards. We believe that the Competency Based Curriculum will help in bridging the skill gap between industry’s needs and training institutes thereby enhance the employability of the technical graduates.

The Department acknowledges the valuable contributions made by institutes, officials, and experts from relevant industries who were involved in the design and development of this curriculum. As it is a dynamic document which may require revision based on the needs of the changing labour market, the Department look forward to receiving valuable feedbacks from the institutes and the industries to further improve and refine the curriculum

The Department hope that this document will help advance Competency Based Learning in most of the TVET Institutions.



(Sangay Dorji)

Officiating Director

Department of Workforce Planning and Skills Development

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COMPETENCY PROFILE

Trade: Digital Fabrication BQF Certificate 3

Competency Area	Sub- Competency Area	Competencies/Tasks			
A: Carry out Basic 2D and 3D Designing using CAD Software	A1: Create basic 2D Digital Model	A1.01 Install designing software	A1.02 Create 2D sketch	A1.03 Modify 2D sketches	
	A2: Create basic 3D Digital Model	A2.01 Install designing software	A2.02 Create 2D sketch	A2.03 Design 3D model	A2.04 Assemble 3D models
	A3: Perform file processing	A3.01 Convert file	A3.02 Compress file	A3.03 Archive files	
B: Carry out basic 3D printing operations	B1: Prepare print ready 3D models	B1.01 Design print ready 3D models	B1.02 Install slicer software	B1.03 Slice 3D model	
	B2: Prepare 3D printers	B2.01 Setup 3D printer	B2.02 Calibrate 3D printer		
	B3: Execute and monitor print job	B3.01 Perform printing	B3.02 Perform post processing	B3.03 Perform product inspection	
C: Carry out basic laser cutting operation	C1: Prepare fabrication ready files	C1.01 Design for cutting	C1.02 Design for engraving	C1.03 Install machine software	
	C2: Prepare laser cutter	C2.01 Perform pre-check	C2.02 Prepare job for operation	C2.03 Set up machine	
	C3: Execute and monitor laser operation	C3.01 Perform laser operation	C3.02 Monitor laser operation	C3.03 Perform kerf test	C3.04 Perform post processing
		C3.05 Perform product inspection			

D: Carry out Basic CNC Router Operations	D1: Prepare for CAM (Computer Aided Manufacturing)	D1.01 Install software	D1.02 Design for CNC machining		
	D2: Prepare for CNC router operation	D2.01 Perform precheck	D2.02 Mount job piece	D2.03 Mount cutting tools	D2.04 Set up machine
	D3: Perform CNC router programming	D3.01 Program profile cutting	D3.02 Program drilling	D3.03 Program pocketing	D3.04 Program engraving
	D4: Execute and monitor CNC router operation	D4.01 Perform CNC operation	D4.02 Perform post processing	D4.03 Perform product inspection	
E: Maintain Digital Fabrication Machines and Accessories	E1: Apply basic electrical theory	E1.01 Test conductor and insulator	E1.02 Measure resistance	E1.03 Measure voltage	E1.04 Measure current
	E2: Apply basic electronics theory	E2.01 Perform soldering	E2.02 Test inductor	E2.03 Test capacitor	E2.04 Test diode
		E3.05 Test transistors			
	E3: Maintain 3D Printer	E3.01 Maintain logs and documentation	E3.02 Clean extruder	E3.03 Lubricate moving parts	E3.04 Replace extruder
		E3.05 Replace sensors	E3.06 Replace control board	E3.07 Assemble 3D printer	E3.08 Update firmware
	E4: Maintain laser cutter	E4.01 Lubricate rails and guides	E4.02 Clean machine parts	E4.03 Replace machine bed	E4.04 Clean exhaust system
		E4.05 Perform beam alignment	E4.06 Update firmware	E4.07 Calibrate auto focus	
	E5: Maintain CNC Router Machine	E5.01 Perform machine inspection	E5.02 Clean machine parts	E5.03 Lubricate machine parts	E5.04 Clean dust collector

COURSE INFORMATION

COURSE TITLE	Digital Fabrication
LEVEL	BQF Certificate Level 3
COURSE OBJECTIVE	Upon completion of this training program, the trainees will be able to: • Carry out Basic 2D and 3D Designing using CAD Software • Carry out basic 3D printing operations • Carry out basic laser cutting operation • Carryout Basic CNC Router Operations • Maintain Digital Fabrication Machines and Accessories
COURSE DESCRIPTION	This course is designed to provide trainees with the knowledge, skills and attitudes required to be competent Digital Fabrication Technician. This course will prepare the trainees to exhibit professionalism, teamwork, adaptability, and safety practices as per the requirement of the workplace. To obtain certification of this course, all learning outcomes prescribed must be achieved.
COURSE DURATION	1310 Hours
TRAINER AND TRAINEE RATIO	1:12 (Practical) 1:20 (Theory)
ENTRY REQUIREMENT	Completed class X
TVET TRAINER REQUIREMENTS	• Must have a minimum qualification of Diploma in relevant field (or) Certificate 3 with minimum of 5 years of working experience; • Must have undergone Training of Trainers-Technical Instruction and Andragogy; • Must have at least 5 years job/industry experience if institute hires instructor or guest lecturer from industry

COURSE OUTLINE

Sl. No	Subject /Module	Duration (Hours)	Content Competencies (Mapped)
1.	Core modules	560	CC
2.	OJT	280 (2 months)	CC
Total hours for Core Competencies (CC)		840	
1.	Applied Dzongkha	42	SS
2.	ICT	48	SS
3.	Engineering drawing	34	
4.	OHS	34	
5.	Ethics and integrity	68	
6.	Applied Mathematics	53	SS
7.	Technical English	51	SS
8.	Entrepreneurship	70	
Total hours for Soft Skills (SS)		400	
1.	Assessment	70	
Entire Course Duration		1310	

Note:

- 35 Hours per week and 7 hours per day
- (*) This curriculum contains core modules which cover main competencies of Digital Fabrication BQF Certificate level-3 and OJT component. There are separate curricula for subjects/modules for delivery of soft skills, professional development & values and environmental concern & safety. In order to achieve the qualification of Digital Fabrication BQF Certificate level 3, the subjects and modules listed must be accomplished as per the credit hours provided.

Content Competencies:

CC-Core Competencies

SS-Soft Skills

PD-Professional Development and Values

ES-Environmental concern and Safety

COURSE STRUCTURE FOR CORE COMPETENCIES

Training Modality	Module Title	Learning outcomes	Nominal Duration (Hour)
1. Institute Training	A. Carry out Basic 2D and 3D Designing using CAD Software	A1. Create basic 2D Digital Model A2. Create basic 3D Digital Model A3. Perform file processing	81
	B. Carry out basic 3D printing operations	B1. Prepare print ready 3D models B2. Prepare 3D printers B3. Execute and monitor print job	77
	C. Carry out basic laser cutting operation	C1. Prepare fabrication ready files C2. Prepare laser cutter C3. Execute and monitor laser operation	84
	D. Carryout Basic CNC Router Operations	D1: Prepare for CAM (Computer Aided Manufacturing) D2. Set up machine D3. Perform CNC programming D4. Execute and monitor CNC operation	140
	E. Maintain Digital Fabrication Machines and Accessories	E1. Apply basic electrical theory E2. Apply basic electronics theory E3. Maintain 3D Printer E4. Maintain Laser Cutting Machine E5. Maintain CNC Router Machine	178
2. On the Job Training	A. Carry out basic 3D printing operations	A1. Prepare print ready 3D models A2. Prepare 3D printers A3. Execute and monitor print job	280/2 months
	B. Carry out basic laser cutting operation	B1. Prepare fabrication ready files B2. Prepare laser cutter B3. Execute and monitor laser operation	
	C. Carryout Basic CNC Router Operations	C1: Prepare for CAM (Computer Aided Manufacturing) C2. Set up machine C3. Perform CNC programming C4. Execute and monitor CNC operation	
	D. Maintain Digital Fabrication Machines and Accessories	D1. Maintain 3D Printer D2. Maintain Laser Cutting Machine D3. Maintain CNC Router Machine	
Total CC Duration:			

ASSESSMENT AND CERTIFICATION SYSTEM

ASSESSMENT	Diagnostic assessment of each skill will be conducted to identify areas where trainees may require additional support or intervention. This assessment will also evaluate their existing knowledge, skills, and understanding prior to a specific learning experience or unit of study. Methods such as pre-tests, concept mapping, KWL charts, and observations of student work will be utilized. Formative assessment for every module and learning outcome will be conducted through assignments, project works, continuous assessment, demonstration of practical skills/observations, oral questioning and written test. Summative assessment after completion of each national certificate level will be conducted by TVET Quality Council, Bhutan Qualifications and professional certification authority, MoESD as per the National Competency Standards and Guidelines for National Assessment and Certification System, provided the course is accredited with TVET Quality Council, Bhutan Qualifications and professional certification authority, MoESD.
CERTIFICATION	On successful completion of every module, the institute will award a certificate of achievement to the trainees. The TVET Quality Council, Bhutan Qualifications and professional certification authority, MoESD will award a National Certificate to the trainees upon the successful completion of NC level assessment.
COURSE DELIVERY	1. Modular 2. Demonstration 3. Lecture 4. Industrial training/attachment 5. Project work 6. Problem-based learning 7. Project-based learning
RESOURCES	Materials • Pen, notebook, USB cable, cleaning agent, filament, A4 sheet, 3D printer manual, polishing paste, fasteners, sandpaper, putty, primer, acrylic paints, adhesives, epoxy resin, precheck list, job piece (acrylic, plywood, cardboard, etc.), masking tape, markers, cleaning kits, paint, job piece securing accessories, solvents, protective coatings, wax, varnish, endmill, drill bit, wire/metal, plastic or rubber/wood, connectors, resistor, alligator clip, soldering flux, soldering lead, solder wick, wire, inductor, capacitor, diode, load, transistor, log format, acupuncture needle, cleaning kit, lubricants, sensor, cable ties, user manual, extruder, thermal paste, PTFE tube, paper towels, lithium grease or lubricant oil, microfiber towels, laser machine bed, filters, waste disposal bags, flashlight, brush set, grease gun and blower Tools • Tweezer, snipper, cleaning tools, plier, deburring tools, spatula, magnifying glass, micro cutter, file set, container, paint brush set, focus gauge, soft brushes, clamps, wrench, collet, cutting tools, chisel, file set, mallet, neon tester, wire stripper, desoldering pump, snipper, wire brush, hex key and syringe

	Instruments • Ruler, vernier caliper, measuring tape, spirit level, multimeter, voltmeter, ammeter and LCR meter Software • Inkscape, Fusion360, Git, CAD/Vector graphic software, Slicer software, machine software and control software Equipment • Computer with internet connectivity and accessories, SD card reader, external storage, 3D printer, SD card, 3D pens, micro-SD card, micro-SD card reader, laser cutter, CNC router, Vacuum cleaner, drilling machine, AC/DC source, breadboard, Soldering iron set, soldering mat, breadboard, exhaust system, compressed air blower, hot air gun and dust collector system PPE • Workshop dress, hair net, safety mask, gloves, apron, goggles, earmuff and safety boots Learning Materials • Competency Based Learning Materials (CBLM) • Reference books • Hand-outs • Audio visuals Infrastructure and training facilities • <i>Theory classroom size:</i> Minimum of 1 m² per trainee; • <i>Practical Workshop size:</i> Minimum of 2.25 m² per trainee. Variables must be considered depending upon type of skills being taught and the number of trainees participating at a time.
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MODULE INFORMATION

DIGITAL FABRICATION

MODULE 1: CARRYING OUT BASIC 2D AND 3D DESIGNING USING CAD SOFTWARE

MODULE INFORMATION

Occupation	Digital Fabrication Technician
Competency Area	Carry out Basic 2D and 3D Designing using CAD Software
Module Title	Carrying out Basic 2D and 3D Designing using CAD Software
Module Code	3115-L3-M1
Module Description	This module is structured to provide learners with the knowledge, skills and right attitude required to create basic 2D digital model, 3D digital model and perform file processing
Nominal Duration	81Hours
Certificate Level	BQF Certificate 3
Pre-requisite	Class X passed
Learning Outcome	1. Create basic 2D digital Model 2. Create basic 3D digital model 3. Perform file processing

Module Title	Carrying out Basic 2D and 3D Designing using CAD Software		
Module Code	3115- L3-M1		
Learning Outcome 1	Create basic 2D digital model		
Duration	Theory:13 hours	Practical:13 hours	Total:26 hours
Assessment Criteria	- Designing software is installed as per the job requirement following standard procedure 2D sketch is created as per the job requirement following standard procedure 2D sketch is modified as per the job requirement following standard procedure		
Content	A1.00 Introductory knowledge - Introduction to Digital Fabrication - Introduction to digital fabrication machines - Methods of fabrication - Types of manufacturing - Introduction to prototyping - Introduction to Intellectual Property Rights - Application of digital fabrication - Advantages and limitation of digital fabrication - Scope of digital fabrication technician - Concept of simple machines A1.01 Installing design software Knowledge - Basics of 2D design software - License types and management - System requirements Skills - ICT skills - Analytical skills Attitude, safety, and environmental concern - Effective time management - Being efficient in using resources - Having work ethics and integrity - Proper handling of tools, materials and equipment - Ensuring correct use of PPE - Ensuring to follow OHS rules and regulation - Ensuring compatible and complete download A1.02 Creating 2D sketches Knowledge - Introduction to coordinate systems - Units and measurements - Dimensioning and control of size - Geometric relationships (edges, vertices, faces)		

	• Types of images • Difference between vector and raster image format • Design thinking Skills • Basic engineering drawing skills • Using CAD software • Using measuring tools • Analytical skills • ICT skills • Numeracy skills Attitude, safety, and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation A1.03 Modifying 2D sketches Knowledge • Difference between path and shapes • Introduction to nodes and segments • Purpose of modifying sketches Skills • Basic engineering drawing skills • Using CAD software • Using measuring tools • Analytical skills • ICT skills • Numeracy skills Attitude, safety, and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation
Learning Conditions	Learning Materials • Competency-Based Learning Materials (CBLM)/reference materials • Hand-outs • Audio Visuals • Manuals Learning facilities and infrastructure • Classroom with adequate facilities

	• Information Technology (IT) lab • Library • Digital Fabrication Lab Materials • Pen and notebook Software • Inkscape Equipment • Computer with internet connectivity and accessories PPE • Workshop dress and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carry out Basic 2D and 3D Designing using CAD Software		
Module Code	3115- L3-M1		
Learning Outcome 2	Create basic 3D Digital Model		
Duration	Theory:10 hours	Practical:32 hours	Total:42 hours
Assessment Criteria	• Designing software is installed as per the job requirement following standard procedure • 2D sketch is created as per the job requirement following standard procedure • 3D model is designed as per the job requirement following standard procedure • 3D model is assembled as per the job requirement following standard procedure		
Content	A2.01 Installing designing software Knowledge • Basics of CAD software • Types of CAD software (3D design) Skills • ICT skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation • Ensuring compatible and complete file download A2.02 Creating 2D sketch Knowledge • Introduction to coordinate systems and planes • Introduction to sketch palettes • Introduction to parametric design • Sketch constraints (horizontal, vertical, tangent) • Dimensioning and control of size • Types of lines • Shortcut keys for 2D sketching Skills • Basic engineering drawing skills • Using measuring tools • Using CAD software • Creativity • Analytical skills • ICT skills • Numeracy skills		

	<i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation • Ensuring to prioritize accuracy and precision A2.03 Designing 3D models <i>Knowledge</i> • Importance of 3D modeling in digital fabrication • Difference between 2D sketch and 3D model • Difference between sketch and body • Features of 3D design software (sketching, modeling and modifying) • 3D model file formats • Purpose of chamfer and fillet • Geometric relationships (edges, vertices, faces) • Concept of gears <i>Skills</i> • Using CAD software • Basic engineering drawing skills • Using measuring tools • ICT skills • Spatial visualization • Creativity • Analytical skills • Problem-solving skills • Numeracy skills <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation • Ensuring to prioritize accuracy and precision A2.04 Assembling 3D models <i>Knowledge</i> • Introduction to components and joints • Types of joints • Degrees of freedom and constraints • Basic kinematic pair and Mechanism Theory • Materials, Fits and Tolerances
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	• Advantages of parametric designing Skills • Using CAD software • Spatial visualization • Creativity • Basic engineering drawing skills • Using measuring tool • Analytical skills • ICT skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to prioritize accuracy and precision
Learning Conditions	Learning Materials • CBLM/Reference materials • Hand-outs • Audio Visuals • Manuals Learning Facilities and infrastructure • Classroom with adequate facilities • Information Technology (IT) lab • Library • Digital fabrication Lab Materials • Pen and paper Software • Fusion360 Instruments • Ruler and vernier caliper (if replicating a real object) Equipment • Computer with internet connectivity and accessories PPE • Workshop dress and safety boots

Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carry out Basic 2D and 3D Designing using CAD Software		
Module Code	3115- L3-M1		
Learning Outcome 3	Perform file processing		
Duration	Theory:4 hours	Practical:9 hours	Total:13 hours
Assessment Criteria	- File is converted as per the standard procedure - File is compressed as per the standard procedure - File is archived as per the standard procedure		
Content	A3.01 Converting file Knowledge - File formats - Methods of file conversion Skills - ICT skills - Problem-solving skills - File management skills Attitude, safety, and environmental concern - Effective time management - Being efficient in using resources - Being vigilant and patient - Having work ethics and integrity - Proper handling of tools, materials and equipment - Ensuring correct use of PPE - Ensuring proper disposal of waste - Ensuring to follow OHS rules and regulation - Ensure to keep file backups - Ensure to maintain correct file format A3.02 Compressing file Knowledge - File structures and formats - Encryption and Decryption Skills - ICT skills - Analytical skills Attitude, safety and environmental concern - Effective time management - Being efficient in using resources - Being vigilant and patient - Having work ethics and integrity - Proper handling of tools, materials, and equipment - Ensuring correct use of PPE - Ensuring proper disposal of waste - Ensuring complete file compression - Ensuring to follow OHS rules and regulation		

	A3.03 Archiving files Knowledge • Introduction to cloud services • Introduction to version control platform • Introduction to Git • Introduction to basic commands in Git • Introduction to Command Line Interface • Concepts of repository • Introduction to remote and local repositories Skills • Using basic command line tools • Observation skills • Communication skills • Analytical skills • ICT skills • File management skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation
Learning Conditions	Learning Materials • CBLM/reference materials • Hand-outs • Audio Visuals • Manuals Learning Facilities and infrastructure • Classroom with adequate facilities • Information Technology (IT) lab • Library Materials • Pen and notebook Software • Inkscape, fusion360 and Git Equipment • Computer with internet connectivity and accessories PPE • Workshop dress and safety boot

Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment

MODULE 2: CARRYING OUT BASIC 3D PRINTING OPERATIONS

MODULE INFORMATION

Occupation	Digital Fabrication Technician
Competency Area	Carry out basic 3D printing operations
Module Title	Carrying out basic 3D printing operations
Module Code	3115- L3-M2
Module Description	This module is structured to provide the learners with knowledge, skills and right attitude to prepare print ready 3D models, prepare 3D printers and execute and monitor print jobs
Nominal Duration	77 Hours
Qualification Level	BQF Certificate Level 3
Pre-requisite	Completed Module: 3115-L3-M1
Learning Outcome	1. Create print ready 3D models 2. Prepare 3D printers 3. Execute and monitor print jobs

Module Title	Carrying out basic 3D printing operations		
Module Code	3115- L3-M2		
Learning Outcome 1	Prepare print ready 3D models		
Duration	Theory:7 hours	Practical:18 hours	Total:25 hours
Assessment Criteria	• Print ready 3D models is designed as per the job requirement following standard procedure • Slicer software is installed as per the job requirement following standard procedure • 3D model is sliced as per the job requirement following standard procedure		
Content	B1.01 Designing print ready 3D models Knowledge • Introduction to additive manufacturing • Types of additive manufacturing and materials used • Types of 3D printer • Parts of 3D printer • Types of filaments and its usages • 3D printing design rules Skills • Using CAD software • Using measuring tool • Basic engineering drawing skills • Analytical skills • ICT skills • Problem-solving skills Attitude, safety, and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring to prioritize accuracy and precision • Ensuring to follow OHS rules and regulation B1.02 Installing slicer software Knowledge • Introduction to slicing and its role in 3D printing • Introduction to slicing software (PrusaSlicer, Cura) • System requirements and compatibility Skills • Analytical skills • ICT skills • Problem-solving skills Attitude, safety, and environmental concern • Effective time management • Being efficient in using resources		

	• Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring compatible and complete download from official sources B1.03 Slicing 3D model Knowledge • Slicing parameters • Introduction to G-code • Print model analysis • Product estimation and costing Skills • Interpreting datasheet • Analytical skills • Spatial visualization • ICT skills • Problem solving skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to prioritize accuracy and precision
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio Visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Information Technology (IT) lab • Library • Digital fabrication lab Materials • Pen, notebook and USB cable Software • CAD software and slicer software

	Equipment • Computer with internet connectivity and accessories, SD card reader and external storage PPE • Workshop dress and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carry out basic 3D printing operations		
Module Code	3115- L3-M2		
Learning Outcome 2	Prepare 3D printers		
Duration	Theory:3 hours	Practical:7 hours	Total:10 hours
Assessment Criteria	• 3D printer is set up as per the job requirement following standard procedure • 3D printer is calibrated as per the job requirement following standard procedure		
Contents	B2.01 Setting up 3D printer Knowledge • Environment required for printer operation • Properties of filament • Cleaning tools and agents, and its purposes Skills • Using hand tools • Analytical skills • Observation skills • Problem solving skills Attitude, safety, and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation • Ensuring proper setup and pre-checks of the 3D printer before operation B2.02 Calibrating 3D printer Knowledge • Introduction to calibration • Calibration processes in 3D printer • Types of print bed • Purpose and process of Z-offset calibration Skills • Operating 3D printer • Analytical skills • Interpreting user manual • Observation skills • Using measuring tools Attitude, safety, and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE		

	• Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation
Learning Conditions	Learning Materials • CBLM/reference materials • Hand outs • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • IT lab • Library • Digital fabrication Lab Materials • Pen, notebook, cleaning agent, filament, A4 sheet and 3D printer manual Tools • Tweezer, snipper and cleaning tools Equipment • 3D printer and SD card PPE • Workshop dress and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment

Module Title	Carrying out basic 3D printing operations		
Module Code	3115- L3-M2		
Learning Outcome 3	Execute and monitor print job		
Duration	Theory:6 hours	Practical:36 hours	Total:42 hours
Assessment Criteria	• Printing is performed as per the job requirement following standard procedure • Post processing is performed as per the job requirement following standard procedure • Product inspection is performed as per the job requirement following standard procedure		
Contents	B3.01 Performing printing Knowledge • Print failure modes • Pattern recognition • Causes, symptoms and remedies of print failure Skills • Analytical skills • Observation Skills • Operating 3D printer • Problem solving skills Attitude, safety, and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring proper calibration and maintenance of 3D printers • Ensuring to compare actual print progress against estimated progress B3.02 Performing post processing Knowledge • Post processing techniques • Basic color theory • Joining techniques and adhesives Skills • Analytical skills • Observation Skills • Using hand tools • Creativity Attitude, safety, and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity		

	• Proper handling of tools, material and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensure proper finishing of printed products B3.03 Performing product inspection <i>Knowledge</i> • Inspection tools and techniques • Basic functional test <i>Skills</i> • Analytical skills • Observation skills • Problem solving skills • Numeracy skills • Using hand tools • Operating 3D printer • Using CAD software • Using slicer software <i>Attitude, safety, and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation
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Learning Conditions	Learning Materials • CBLM/reference materials • Handouts • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Digital fabrication Lab Materials • Pen, notebook, filament, cleaning agent, polishing paste, fasteners, sandpaper, putty, primer, acrylic paints, adhesives and epoxy resin Tools • Tweezer, cleaning tools, snippers, plier, deburring tools, spatula, magnifying glass, micro cutter, file set, container and paint brush set Instrument • Caliper, micrometer, ruler, weighing scale and gauges Software • CAD software and slicer software Equipment • 3D printer with power supply, SD card and 3D pen PPE • Workshop dress and safety boot
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

MODULE 3: CARRYING OUT BASIC LASER CUTTING OPERATION

MODULE INFORMATION

Occupation	Digital Fabrication Technician
Competency Area	Carry out basic laser cutting operation
Module Title	Carrying out basic laser cutting operation
Module Code	3115- L3-M3
Module Description	This module is structured to provide the learners with knowledge, skills and right attitude required to prepare fabrication ready files, prepare laser cutter and execute and monitor laser operation.
Nominal Duration	84 Hours
Qualification Level	BQF Certificate Level 3
Pre-requisite	Completed Module 3115-L3-M2
Learning Outcome	1. Prepare fabrication ready files 2. Prepare laser cutter 3. Execute and monitor laser operation

Module Title	Carrying out basic laser cutting operation		
Module Code	3115- L3-M3		
Learning Outcome 1	Prepare fabrication ready files		
Duration	Theory:7 hours	Practical:14 hours	Total:21 hours
Assessment Criteria	- Design for cutting is prepared as per the job requirement following standard procedure - Design for engraving is prepared as per the job requirement following standard procedure - Software is installed as per the job requirement following standard procedure		
Content	C1.01 Designing for cutting Knowledge - Introduction to subtractive manufacturing - Introduction to laser cutter - Types of lasers and their application - Introduction to laser cutting and engraving - Components of laser cutter - Working principle of laser cutter (Fiber and CO2) - Stroke and Fill differences - Print file preparation requirements (line thickness, RGB colour coding, dimensions) Skills - Using CAD software - Analytical skills - Creativity - Numeracy skills - ICT skills Attitude, safety and environmental concern - Effective time management - Being efficient in using resources - Being vigilant and patient - Having work ethics and integrity - Proper handling of tools, materials and equipment - Ensuring correct use of PPE - Ensuring proper disposal of waste - Ensuring to follow OHS rules and regulation - Ensuring to prioritize design accuracy and precision C1.02 Designing for engraving Knowledge - Design parameters for engraving - Image tracing parameters - Types of engraving - Materials used for engraving - Engraving vs. Marking Skills - ICT skills		

	• Analytical skills • Creativity • Using CAD software • Numeracy skills <i>Attitude, safety, and environmental concern</i> • Effective time management • Being a team player • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Having a sense of ownership and accountability • Ensuring correct use of PPE • Ensuring to follow environmental rules and regulations • Ensuring to follow OHS rules and regulation • Ensuring to prioritize for accuracy and precision C1.03 Installing machine software <i>Knowledge</i> • Introduction to laser machine software • Importance of Ghostscript folder for machine software installation • Machine computer interface <i>Skills</i> • Analytical skills • ICT skills • Interpreting user manual <i>Attitude, safety and environmental concern</i> • Effective time management • Being a team player • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Having a sense of ownership and accountability • Ensuring correct use of PPE • Ensuring to follow environmental rules and regulations • Ensuring to follow OHS rules and regulation • Ensuring to temporarily disable Anti-Virus protection during installation, if required • Ensuring complete download from official sources
Learning Conditions	Learning Materials • CBLM/reference materials • Hand-outs • Audio Visuals • Manuals Learning Facilities and infrastructure • Classroom with adequate facilities • Information Technology (IT) lab

	• Library • Digital fabrication lab Materials • Pen, paper, ethernet or USB cable and user manual Software • Inkscape and machine software Equipment • Computer with internet connectivity & accessories, micro-SD card, micro-SD card reader and laser cutter PPE • Workshop dress and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carry out basic laser cutting operation		
Module Code	3115- L3-M3		
Learning Outcome 2	Prepare laser cutter		
Duration	Theory:4 hours	Practical:10 hours	Total:14 hours
Assessment Criteria	• Precheck is performed as per the job requirement following standard procedure • Job is prepared for operation as per the job requirement following standard procedure • Machine is set up as per the job requirement following standard procedure		
Contents	C2.01 Performing precheck Knowledge • Importance of performing precheck • Importance of laser air assist and laser Exhaust system • Importance of maintaining precheck list Skills • Analytical skills • Observation skills • Interpreting user manual • Record keeping skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation C2.02 Preparing job for operations Knowledge • Types and properties of job piece used in laser operation • Methods of securing job piece • Usages of paints in job preparation Skills • Using cutting tools • Observation skills • Analytical skills • Using measuring tools • Creativity Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE		

	• Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring proper material selection • Ensuring to secure material properly on machine bed C2.03 Setting up machine Knowledge • Introduction to Absolute Coordinate system, Relative Coordinate System and Machine Home coordinates • Importance of setting focal length • Laser machine User Interface Skills • Analytical skills • ICT skill • Observation skills • Interpreting user manual Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring proper electrical connections • Ensuring proper focus setup
Learning Conditions	Learning Materials • CBLM/reference material • Hand-outs • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Digital fabrication Lab Materials • Pen, cleaning agents, user manual, precheck list, notebook, job piece (acrylic, plywood, cardboard, etc), masking tape, markers, cleaning kits, paint and job piece securing accessories Tools • Cleaning tools, Allen key set and focus gauge Instrument • Measuring tools

	Equipment • Laser cutter and cutting equipment (Bandsaw, CNC, etc) PPE • Workshop dress, hair net, safety mask, gloves and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment

Module Title	Carry out basic laser cutting operation		
Module Code	3115- L3-M3		
Learning Outcome 3	Execute and monitor laser operation		
Duration	Theory:8 hours	Practical:41 hours	Total:49 hours
Assessment Criteria	• Laser operation is performed as per the job requirement following standard procedure • Laser operation is monitored as per the job requirement following standard procedure • Kerf test is performed as per the job requirement following standard procedure • Post processing is performed as per the job requirement following standard procedure • Product inspection is performed as per the job requirement following standard procedure		
Contents	C3.01 Performing laser operation Knowledge • Principles of laser cutting and engraving • Machine settings (power, speed, frequency, passes) • Importance of setting machines according to material used • Importance of test run • Order of laser operation • Purpose of exhaust and air assist system • Materials reaction to laser Skills • Using CAD software • Interpreting user manual • Analytical skills • ICT skills • Problem-solving skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring proper exhaust/ventilation and air assist C3.02 Monitoring laser operation Knowledge • Purpose of door and safety interlock • Sparks vs. flame • Common laser cutter problems and its remedies • Safety precautions while operating laser cutter		

	Skills • Observation skills • Analytical skills • Interpreting user manual Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring proper exhaust/ventilation and air assist • Ensuring to press emergency push button in case of any abnormal operations C3.03 Performing kerf test Knowledge • Introduction to Pressfit designing • Purpose of Kerf test • Process of Kerf test • Kerf value calculation • Effects of Kerf width on cut quality Skills • Observation skills • Analytical skills • Interpreting user manual • Numeracy skills • Using measuring tools Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring proper exhaust/ventilation and air assist • Ensuring accurate calculation of kerf • Ensuring to select non-defective material C3.04 Performing post processing Knowledge • Finishing Methods for different material • Joining methods suitable for different products • Protective finishing materials
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	Skills • Analytical skills • Observation Skills • Using measuring tools • Using hand tools • Creativity • Problem solving skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring proper finishing of laser-cut/engraved products C3.05 Performing product inspection Knowledge • Inspection tools and techniques • Basic functional test Skills • Analytical skills • Observation skills • Problem-solving skills • Numeracy skills • Using hand tools • Using measuring tools Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to prioritize precision and accuracy
Learning Conditions	Learning Materials • CBLM/reference material • Hand-outs • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab

	- Digital Fabrication Lab Materials - Pen, notebook, cleaning kit, Job securing accessories, job piece, sandpaper, polishing paste, adhesives, solvents, protective coatings, wax and varnish Tools - Allen key set, cutting tools, focus gauge, tweezers, pliers, deburring tools, files, soft brushes and clamps Instruments - Measuring tools Software - CAD software and machine software Equipment - Computer with internet connectivity, laser cutter and vacuum cleaner PPE - Workshop dress, safety mask, gloves, safety goggles and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: - Lecture - Interactive discussion - Demonstration - Industrial visit/training - Guided practice - Group practice with project-based learning - Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: - Practical observation - Oral/viva-voce - Written test - Assignment - Project work

MODULE 4: CARRYING OUT BASIC CNC ROUTER OPERATIONS

MODULE INFORMATION

Occupation	Digital Fabrication Technician
Competency Area	Carry out Basic CNC Router Operations
Module Title	Carrying out Basic CNC Router Operations
Module Code	3115- L3-M4
Module Description	This module is structured to provide the learners with knowledge, skills and right attitude required to prepare for CAM, prepare for CNC router operation, perform CNC programming and execute CNC operation.
Nominal Duration	140 Hours
Qualification Level	BQF Certificate Level 3
Pre-requisite	Completed Module 3115-L3-M3
Learning Outcome	1. Prepare for CAM 2. Prepare for CNC router operation 3. Perform CNC router programming 4. Execute and monitor CNC router operation

Module Title	Carry out basic CNC router operation		
Module Code	3115-L3-M4		
Learning Outcome 1	Prepare for CAM		
Duration	Theory:4 hours	Practical:17 hours	Total:21 hours
Assessment Criteria	• Software is installed as per the job requirement following standard procedure • Design is created for CNC machining as per the job requirement following standard procedure		
Contents	D1.01 Installing software Knowledge • Types of CNC machines • NC Vs. CNC machine • Basics of CAM software • Introduction to machine control software Skills • ICT skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring complete download of files D1.02 Designing for CNC machining Knowledge • Introduction to dogbone fillet • Purpose of dogbone fillet • File format used in CNC machine • Difference between laser cutting and CNC milling • Introduction to relief model Skills • Using CAD/CAM software • ICT skills • Numeracy skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment		

	• Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to prioritize precision and accuracy
Learning Conditions	Learning Materials • CBLM/reference material • Hand-outs • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Digital fabrication Lab Materials • Pen and notebook Software • CAD/CAM software and control software Equipment • Computer with internet connectivity and accessories PPE • Workshop dress and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Assignment • Project work

Module Title	Carrying out basic CNC router operation		
Module Code	3115-L3-M4		
Learning Outcome 2	Prepare for CNC router operation		
Duration	Theory:7 hours	Practical:21 hours	Total:28 hours
Assessment Criteria	• Precheck is performed as per the job requirement following standard procedure • Job piece is mounted as per the job requirement following standard procedure • Cutting tool is mounted as per the job requirement following standard procedure • Machine is set up as per the job requirement following standard procedure		
Contents	D2.01 Performing precheck Knowledge • Parts of CNC router • Working principle of CNC router • Machine coordinates systems Skills • Analytical skills • Observation skills • ICT skills • Interpreting user manual • Record keeping skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to perform precheck as per the checklist D2.02 Mounting job piece Knowledge • Methods of securing job pieces (clamps, vacuum, adhesives) • Importance of job alignment and flatness • Purpose of checking clearance Skills • Using hand tools • Problem-solving skills • Analytical skills • Observation skills • Using measuring tools Attitude, safety and environmental concern • Effective time management		

	• Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring work area is free of obstructions and chips D2.03 Mounting cutting tools <i>Knowledge</i> • Tool types and Functions • Properties of endmill • Terminologies used in CNC machining (feed rate, plunge rate, RPM, etc) • Chip load and feed rate calculation • Importance of testing tool runout and alignment <i>Skills</i> • Analytical skills • Creativity • Using hand tools • Interpreting user manual • Observation skills • Problem solving skills <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation D2.04 Setting up machine <i>Knowledge</i> • CNC origin set up(X, Y, Z) • Methods of Z-calibration • Purpose of spindle warmup program <i>Skills</i> • Operating CNC router • Analytical skills • Observation skills • Interpreting of User manual <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity
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	• Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to prioritize precision and accuracy
Learning Conditions	Learning Materials • CBLM/reference material • Hand-outs • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Digital fabrication lab Materials • Pen, notebook, Job piece/work piece (wood, acrylic, metal, etc.), endmill, USB/LAN cable and user manual Tools • Mounting tools & accessories, wrench and collet Instrument • Spirit level and measuring tape Software • Control software Equipment • Computer with internet connectivity, CNC router and vacuum cleaner PPE • Workshop dress, safety mask, gloves, apron, goggles, earmuff and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment

Module Title	Carry out basic CNC router operation		
Module Code	3115-L3-M4		
Learning Outcome 3	Perform CNC router programming		
Duration	Theory:8 hours	Practical:20 hours	Total:28 hours
Assessment Criteria	• Profile cutting programming is performed as per the job requirement following standard procedure • Drilling programming is performed as per the job requirement following standard procedure • Pocketing programming is performed as per the job requirement following standard procedure • Engraving programming is performed as per the job requirement following standard procedure		
Contents	D3.01 Programming profile cutting Knowledge • Introduction to profile cutting • Toolpath parameters • Purpose of ramps and tabs • Job setup parameters • Tools used in profile cutting • Application of profile cutting • Advantages and limitations of profile cutting using CNC Skills • Using CAD/CAM software • ICT skills • Analytical skills • Numeracy skills • Using measuring tools Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to modify open vectors by using join vectors features D3.02 Programming drilling Knowledge • Introduction to drilling • Difference between drill-bit and endmill • Tools used in drilling • Application of drilling • Advantages and limitations of drilling using CNC		

	Skills • ICT skills • Using CAD/ CAM software • Analytical skills • Using measuring tools Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to calculate chip load correctly D3.03 Programming pocketing Knowledge • Introduction to pocketing • Pocketing vs. profile cutting • Types of pocketing • Tools used in pocketing • Application of pocketing • Advantages and limitations of pocketing using CNC Skills • Using CAD/CAM software • ICT skills • Analytical Skills • Numeracy Skills • Using measuring tools Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to modify open vectors by using join vectors features • Ensuring to prioritize precision and accuracy D3.04 Programming engraving Knowledge • Introduction to engraving • Types of CNC engraving • Laser engraving Vs. CNC engraving • Tools used in engraving
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	• Advantages and limitations of engraving using CNC • Application of engraving Skills • Using CAD/CAM software • ICT skills • Analytical Skills • Numeracy Skills • Using measuring tools Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to modify open vectors by using join vectors features • Ensuring to prioritize precision and accuracy
Learning Conditions	Learning Materials • CBLM/reference material • Hand-outs • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Digital fabrication lab Materials • Pen and notebook Software • CAD/CAM software Instruments • Measuring tools Equipment • Computer with internet connectivity and accessories PPE • Workshop dress and safety boots

Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carry out basic CNC router operation		
Module Code	3115-L3-M4		
Learning Outcome 4	Execute and monitor CNC router operations		
Duration	Theory:6 hours	Practical:57 hours	Total:63 hours
Assessment Criteria	• CNC operation is performed as per the job requirement following standard procedure • Post processing is performed as per the job requirement following standard procedure • Product inspection is performed as per the job requirement following standard procedure		
Contents	D4.01 Performing CNC operations Knowledge • Importance of test run • Purpose of monitoring CNC operation • Common faults during CNC router operation and its remedies • Purpose of coolant in CNC operation • Safety precautions while operating CNC Skills • Using CAD/CAM software • Interpreting user manual • Analytical skills • ICT skills • Problem-solving skills • Observation skills • Operating CNC router Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring proper securing of job piece • Ensure good ventilation • Ensure correct machine and tool settings • Ensuring to prioritize precision and accuracy D4.02 Performing post processing Knowledge • Finishing methods for different materials • Joining methods for different materials Skills • Analytical skills • Observation Skills		

	• Using hand tools • Creativity • Using measuring tools <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensure proper removal and finishing of products D4.03 Performing product inspection <i>Knowledge</i> • Inspection tools and techniques • Basic fit test <i>Skills</i> • Analytical skills • Observation skills • Problem-solving skills • Numeracy skills • Using hand tools • Using measuring tools <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to prioritize precision and accuracy
Learning Conditions	Learning Materials • CBLM/reference material • Hand-outs • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Digital fabrication lab

	Materials • Pen, notebook, cleaning kit, Job securing accessories, job piece, polishing paste, fasteners, sandpaper, primer, protective coatings, wax, clamps, varnish, paints, endmill, drill bit and adhesives Tools • Cutting tools, screwdriver set, chisel, file set, mallet, deburring tool and brushes Instrument • Measuring tape and vernier caliper Software • CAD/CAM software and control software Equipment • Computer with internet connectivity, drilling machine, CNC router and vacuum cleaner PPE • Workshop dress, safety gloves, safety mask, ear muff, apron, goggles and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

MODULE 5: MAINTAIN DIGITAL FABRICATION MACHINES AND ACCESSORIES

MODULE INFORMATION

Occupation	Digital Fabrication Technician
Competency Area	Maintain Digital Fabrication Machines and Accessories
Module Title	Maintaining Digital Fabrication Machines and Accessories
Module Code	3115- L3-M5
Module Description	This module is structured to provide the learners with knowledge, skills and right attitude required to Maintain a 3D printer, laser cutter and CNC router machine.
Nominal Duration	178 Hours
Qualification Level	BQF Certificate 3
Pre-requisite	Completed Module 3115-L3-M4
Learning Outcome	1. Apply basic electrical theory 2. Apply basic electronic theory 3. Maintain 3D printer 4. Maintain laser cutting machine 5. Maintain CNC router machine

Module Title	Maintaining Digital Fabrication Machines and Accessories		
Module Code	3115-L3-M5		
Learning Outcome 1	Apply basic electrical theory		
Duration	Theory:6 hours	Practical:9 hours	Total:15 hours
Assessment Criteria	- Conductor and insulator are tested as per the job requirement following standard procedure - Resistance is measured as per the job requirement following standard procedure - Voltage is measured as per the job requirement following standard procedure - Current is measured as per the job requirement following standard procedure		
Contents	E1.01 Testing conductor and insulator Knowledge - Introduction to conductor, semiconductor and insulator - Types of conductors, insulator and semiconductor - Properties of conductor, insulator and semiconductor Skills - Using multimeter - Observation skills - Analytical skills Attitude, safety and environmental concern - Effective time management - Being efficient in using resources - Being vigilant and patient - Having work ethics and integrity - Proper handling of tools and materials - Ensuring correct use of PPE - Ensuring proper disposal of waste - Ensuring to follow OHS rules and regulation E1.02 Measuring resistance Knowledge - Definition of resistance, resistor and resistivity - Unit and symbol of resistance - Factors affecting resistance - Types of resistor - Application of resistors - Colour coding of resistor - Selection of meter range Skills - Interpreting datasheet - Using multimeter - Analytical skills - Numeracy skills		

	<i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools and materials • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation E1.03 Measuring voltage <i>Knowledge</i> • Concept of series and parallel circuits • Definition of voltage • AC and DC source • Unit and symbol of voltage • Types of voltmeter • Types of power sources • Passive and active electrical components • Polar and non-polar components • Introduction to step-up and step-down transformer <i>Skills</i> • Interpreting datasheet • Interpreting circuit diagrams • Using multimeter • Analytical skills • Numeracy skills <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation E1.04 Measuring current <i>Knowledge</i> • Definition of current • Unit and symbols of current • Types of current • Effects of electric current • Selection of ammeter range • Types of ammeter • Ohm's law and its calculation • Introduction to power • Power calculation
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	Skills • Interpreting datasheet • Using ammeter • Using multimeter • Interpreting circuit diagrams • Analytical skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools and materials • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation
Learning Conditions	Learning Materials • CBLM/reference material • Hand-outs • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • lab Materials • Pen, notebook, wire/metal, plastic or rubber/wood, connectors, resistor and alligator clip Tools • Plier, neon tester and wire stripper Instrument • Multimeter, voltmeter and ammeter Equipment • AC/DC source and breadboard PPE • Workshop dress, safety gloves and safety boots

Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment

Module Title	Maintaining Digital Fabrication Machines and Accessories		
Module Code	3115-L3-M5		
Learning Outcome 2	Apply basic electronic theory		
Duration	Theory:5 hours	Practical:14 hours	Total:19 hours
Assessment Criteria	- Soldering is performed as per the job requirement following standard procedure - Inductor is tested as per the job requirement following standard procedure - Capacitor is tested as per the job requirement following standard procedure - Diode is tested as per the job requirement following standard procedure - Transistor is tested as per the job requirement following standard procedure		
Contents	E2.01 Performing soldering Knowledge - Introduction to soldering - Purpose of soldering and desoldering - Purpose of flux - Types of soldering lead and its sizes - Methods of desoldering Skills - Using soldering iron - Analytical skills - Observation skills - Perceptual motor skills Attitude, safety and environmental concern - Effective time management - Being efficient in using resources - Being vigilant and patient - Having work ethics and integrity - Proper handling of tools, materials and equipment - Ensuring correct use of PPE - Ensuring proper disposal of waste - Ensuring to follow OHS rules and regulation E2.02 Testing inductor Knowledge - Definition of inductor and inductance - Symbol of inductor - Unit of inductance - Characteristics of inductor - Types of inductor - Application of inductor Skills - Interpreting datasheet - Using LCR meter - Analytical skills - Numeracy skills		

	<i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensure proper meter range selection E2.03 Testing capacitor <i>Knowledge</i> • Definition of capacitor and capacitance • Symbol of capacitor • Unit of capacitance • Characteristics of capacitor • Types of capacitor • Application of capacitor <i>Skills</i> • Interpreting datasheet • Using LCR meter • Analytical skills • Numeracy skills <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to proper meter range selection E2.04 Testing diode <i>Knowledge</i> • Definition of diode • Symbol of diode • V-I Characteristics of diode • Types of diode • Application of diode • Importance of testing diode • Diode biasing <i>Skills</i> • Interpreting datasheet • Using multimeter • Analytical skills
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	• Numeracy skills • Observation skills <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to select proper meter range E2.05 Testing transistor <i>Knowledge</i> • Working principle of transistor • Transistor configuration • Transistor biasing • Types of Transistors • Characteristics of transistors • Transistor symbols • Application of transistor <i>Skills</i> • Interpreting datasheet • Using multimeter • Analytical skills • Numeracy skills • Observation skills <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation
Learning Conditions	Learning Materials • CBLM/reference material • Hand-outs • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Digital fabrication lab

	Materials • Pen, notebook, soldering flux, soldering lead, solder wick, wire, inductor, capacitor, diode, load and transistor Tools • Tweezers, wire stripper and desoldering pump Instrument • LCR meter and multimeter Equipment • Soldering iron set, soldering mat, breadboard and exhaust fan PPE • Workshop dress, safety gloves, safety mask, apron, goggles and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment

Module Title	Maintaining Digital Fabrication Machines and Accessories		
Module Code	3115-L3-M5		
Learning Outcome 3	Maintain 3D printer		
Duration	Theory:12 hours	Practical:52 hours	Total:64 hours
Assessment Criteria	• Logs and documentations are maintained as per the job requirement following standard procedure • Extruder is cleaned as per the job requirement following standard procedure • Moving parts are lubricated as per the job requirement following standard procedure • Extruder is replaced as per the job requirement following standard procedure • Sensor is replaced as per the job requirement following standard procedure • Control board is replaced as per the job requirement following standard procedure • 3D printer is assembled is replaced as per the job requirement following standard procedure • Firmware is updated as per the job requirement following standard procedure		
Contents	E3.01 Maintaining logs and documentation Knowledge • Introduction to maintenance • Types of maintenance • Purpose of maintenance • Purpose of maintaining logs and documentation • Key data to be recorded Skills • Record keeping skills • Observation skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to maintain clear record E3.02 Cleaning extruder Knowledge • Filament extruder anatomy • Working principle of filament extruder • Common problems related to filament extruder and their remedies		

	• Over extrusion and under extrusion • Causes of nozzle clogging and its remedies • Methods of cleaning filament extruder <i>Skills</i> • Operating 3D printer • Observation skills • Analytical skills • Using hand tools • Problem solving skills <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation E3.03 Lubricate moving parts <i>Knowledge</i> • Types of lubricants • Importance of lubricant selection • Purpose and interval of lubrication • Effects of lubricant contamination <i>Skills</i> • Operating 3D printer • Observation skills • Analytical skills • Using Hand Tools • Problem Solving Skills • Interpreting user manual <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring correct selection of lubricants E3.04 Replacing extruder <i>Knowledge</i> • Purpose of replacing extruder • Types of extruder
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	Skills • Operating 3D printer • Cable management skills • Analytical skills • Observation skills • Problem-solving skills • Using hand tools • Interpreting user manual • Interpreting circuit diagram Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to disconnect power supply before maintenance • Ensuring to select extruder as per the required specification E3.05 Replacing sensor Knowledge • Types of sensors used in 3D printers and its functions • Sensor calibration procedures • Sensor compatibility • Working principle of sensor • Printer error messages • Causes, symptoms and remedies of sensor failure Skills • Operating 3D printer • Cable management skills • Analytical skills • Observation skills • Problem-solving skills • Using hand tools • Interpreting user manual • Interpreting circuits Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation • Ensuring to disconnect power supply before maintenance
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	• Safe disposal of electronic waste • Ensuring to select the sensor as per the required specification E3.06 Replacing control board <i>Knowledge</i> • Introduction to control board and its parts • LED indicators and error messages • Control board compatibility <i>Skills</i> • Operating 3D printer • Analytical skills • Interpreting user manual • Interpreting circuit diagram • Problem solving skills • Observation skills • Using hand tools • Cable management skills <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation • Ensuring correct selection of control board as per the requirement E3.07 Assemble 3D printer <i>Knowledge</i> • Mechanical assembly of 3D printer • Importance of frame alignment <i>Skills</i> • Operating 3D printer • Analytical skills • Observation skills • Interpreting user manual • Using hand tools • Interpreting circuit diagram • Cable management skills <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation • Ensuring to prioritize accuracy and precision while assembling 3D printer
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	• Ensuring to calibrate the 3D printer E3.08 Updating firmware Knowledge • Introduction to firmware • Firmware vs. software • Purpose of updating firmware • Methods of updating firmware Skills • Analytical skills • Observation skills • Interpreting user manual • ICT skills Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation • Ensuring compatible and complete firmware update
Learning Conditions	Learning Materials • CBLM/reference material • Hand-outs • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Digital fabrication lab Materials • Pen, notebook, log format, acupuncture needle, cleaning kit, lubricants, sensor, cable ties, filament, user manual, extruder, thermal paste, PTFE tube and USB cable Tools • Snipper, allen key, plier, wire brush, tweezer, hex key, syringe and screwdriver set Instrument • Multimeter Equipment • 3D printer with slicing software, compressed air blower and hot air gun

	PPE • Workshop dress, safety gloves, safety mask, apron, goggles and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment

Module Title	Maintaining Digital Fabrication Machines and Accessories		
Module Code	3115-L3-M5		
Learning Outcome 4	Maintain laser cutter		
Duration	Theory:8 hours	Practical:44 hours	Total:52 hours
Assessment Criteria	• Rails and guides are lubricated as per the job requirement following standard procedure • Machine parts are cleaned as per the job requirement following standard procedure • Machine bed is replaced as per the job requirement following standard procedure • Exhaust system is cleaned as per the job requirement following standard procedure • Beam alignment is performed as per the job requirement following standard procedure • Firmware is updated as per the job requirement following standard procedure • Autofocus is calibrated as per the job requirement following standard procedure		
Contents	E4.01 Lubricating rails and guides <i>Knowledge</i> • Purpose of lubrication • Types of lubricant • Intervals of lubrication <i>Skills</i> • Operating laser cutter • Using CAD software • Observation skills • Analytical skills • Problem solving skills • Interpreting user manual <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensure to wipe off excess oil • Ensuring to select correct lubricants E4.02 Cleaning machine parts <i>Knowledge</i> • Types of cleaning agents • Cleaning agent and tool selection		

	Skills • Analytical skills • Using hand tools • Problem solving skills • Interpreting user manual • Operating Laser Cutter • Using CAD software Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to clean the machine parts properly E4.03 Replacing machine bed Knowledge • Types of bed components • Methods of leveling/flatness • Purpose and interval of replacing machine bed Skills • Analytical skills • Observation skills • Problem-solving skills • Using hand tools • Interpreting user manual • Using CAD software • Operating laser cutter Attitude, safety and environmental concern • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring proper alignment and levelling of machine bed E4.04 Cleaning exhaust system Knowledge • Exhaust system and components • Working principles of exhaust system • Filter types and cleaning methods • Environmental effects due to laser fumes
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	<i>Skills</i> • Analytical skills • Observation skills • Problem-solving skills • Using hand tools • Interpreting user manual <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to disconnect power supply before maintenance • Ensuring proper filter installation E4.05 Performing beam alignment <i>Knowledge</i> • Types of mirrors and its purpose • Purpose of beam alignment • Types of laser beams <i>Skills</i> • Analytical skills • Interpreting user manual • Observation skills • Using hand tools • Problem solving skills • Using CAD software • Operating laser cutter • Record keeping skills <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation • Ensuring proper alignment of beams • Ensuring correct marking of mirror center E4.06 Updating firmware <i>Knowledge</i> • Advantages of upgrading firmware <i>Skills</i> • ICT Skill
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	• Problem-solving skills • Analytical skills • Interpreting user manual • Operating laser cutter • Using CAD software • Observation skills <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation • Ensuring compatible and complete download from official sources E2.07 Calibrating autofocus <i>Knowledge</i> • Introduction to focal point • Purpose of calibrating auto focus • Methods of calibrating auto focus • Focusing Vs beam alignment <i>Skills</i> • ICT Skill • Problem-solving skills • Analytical skills • Interpreting User Manual • Observation Skill • Using CAD/CAM software • Operating laser cutter <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring to follow OHS rules and regulation
Learning Conditions	Learning Materials • CBLM/reference material • Hand-outs • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab

	- Digital fabrication lab Materials - Pen and notebook, job piece, weights, clamps, paper towels, lithium grease or lubricant oil, microfiber towels, laser machine bed, cleaning kit, filters, waste disposal bags, flashlight, marker and masking tape Tools - Screwdrivers, Pliers, focus gauge, allen key set, wrench, mallet and cleaning tools Software - CAD/Vector graphic editor software and machine software Instrument - Measuring tape, spirit level and vernier caliper Equipment - Laser cutter, dust blower, vacuum cleaner, computer & accessories and exhaust system PPE - Workshop dress, safety gloves, safety mask, apron, goggles and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: - Lecture - Interactive discussion - Demonstration - Industrial visit/training - Guided practice - Group practice with project-based learning - Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: - Practical observation - Oral/viva-voce - Written test - Assignment

Module Title	Maintaining Digital Fabrication Machines and Accessories		
Module Code	3115-L3-M5		
Learning Outcome 5	Maintain CNC router machine		
Duration	Theory:4 hours	Practical:24 hours	Total:28 hours
Assessment Criteria	- Machine inspection is performed as per the job requirement following standard procedure - Machine parts are cleaned as per the job requirement following standard procedure - Machine parts are lubricated as per the job requirement following standard procedure - Dust collector is cleaned as per the job requirement following standard procedure		
Contents	E5.01 Performing machine inspection <i>Knowledge</i> - Purpose of machine inspection - Methods of inspection - Common signs of mechanical/electrical wears <i>Skills</i> - Record keeping skills - Observation skills - Analytical skills - Operating CNC machine <i>Attitude, safety and environmental concern</i> - Effective time management - Being efficient in using resources - Being vigilant and patient - Having work ethics and integrity - Proper handling of tools, materials and equipment - Ensuring correct use of PPE - Ensuring proper disposal of waste - Ensuring to follow OHS rules and regulation E5.02 Cleaning machine parts <i>Knowledge</i> - Types of cleaning agents - Cleaning agent and tool selection <i>Skills</i> - Using hand tools - Analytical skills - Problem Solving Skills - Observation skills - Using vacuum cleaner <i>Attitude, safety and environmental concern</i> - Effective time management - Being efficient in using resources - Being vigilant and patient		

	• Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensure to clean all the machine parts E5.03 Lubricating machine part <i>Knowledge</i> • Methods of lubrication • Types of lubricants • Interval of lubrication <i>Skills</i> • Observation skills • Problem-solving skills • Using hand tools • Interpreting user manual <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensuring to disconnect power supply before lubrication E5.04 Cleaning dust collector <i>Knowledge</i> • Introduction to dust collection system • Components of dust collection system • Operation of dust collection system <i>Skills</i> • Analytical skills • Problem-solving skills • Using hand tools • Interpreting user manual <i>Attitude, safety and environmental concern</i> • Effective time management • Being efficient in using resources • Being vigilant and patient • Having work ethics and integrity • Proper handling of tools, materials, and equipment • Ensuring correct use of PPE • Ensuring proper disposal of waste • Ensuring to follow OHS rules and regulation • Ensure to disconnect power supply before maintenance
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Learning Conditions	Learning Materials • CBLM/reference material • Hand-outs • Audio-visuals • Manuals Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Digital fabrication lab Materials • Pen, notebook, logbook, cleaning kits, screwdriver, allen key, brush set, lithium grease, filter, waste disposal bag and flashlight Tools • Wrenches, cutting tools, screwdriver, Allen key set and pliers Equipment • Dust collector system, CNC router, vacuum cleaner, grease gun and blower PPE • Workshop dress, safety gloves, safety mask, ear muff, apron, goggles and safety boots
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment

ANNEXURE

Annex I: Time Distribution

Time Distribution (Regular course)					
Digital Fabrication BQF Certificate 3					
Module Title	Learning outcomes	Tasks	Theory	Practical	Total
			(Hours)	(Hours)	(hours)
A: Carry out Basic 2D and 3D Designing using CAD Software	A1: Create basic 2D digital model	A1.00 Introductory knowledge	7	0	7
		A1.01 Install designing software	2	3	5
		A1.02 Create 2D sketch	2	5	7
		A1.03 Modify 2D sketches	2	5	7
	Sub Total		13	13	26
	A2: Create basic 3D digital model	A2.01 Install designing software	2	5	7
		A2.02 Create 2D sketch	2	5	7
		A2.03 Design 3D model	2	12	14
		A2.04 Assemble 3D models	4	10	14
	Sub Total		10	32	42
	A3: Perform file processing	A3.01 Convert file	1	2	3
		A3.02 Compress file	1	2	3
		A3.03 Archive files	2	5	7
	Sub Total		4	9	13
	Total Duration (A)		27	54	81
B: Carry out basic 3D printing operations	B1: Prepare print ready 3D models	B1.01 Design print ready 3D models	2	12	14
		B1.02 Install slicer software	1	3	4
		B1.03 Slice 3D model	4	3	7
	Sub Total		7	18	25
	B2: Prepare 3D printers	B2.01 Setup 3D printer	1	2	3
		B2.02 Calibrate 3D printer	2	5	7
	Sub Total		3	7	10
	B3: Execute and monitor print job	B3.01 Perform printing	3	25	28
		B3.02 Perform post processing	2	5	7
		B3.03 Perform product inspection	1	6	7
	Sub Total		6	36	42
	Total Duration (B)		16	61	77
C: Carry out basic laser cutting operation	C1: Prepare fabrication ready files	C1.01 Design for cutting	3	4	7
		C1.02 Design for engraving	2	5	7
		C1.03 Install machine software	2	5	7
	Sub Total		7	14	21
	C2: Prepare laser cutter	C2.01 Perform pre-check	1	2	3
		C2.02 Prepare job for operation	1	3	4
		C2.03 Set up machine	2	5	7
	Sub Total		4	10	14
	C3: Execute and monitor laser operation	C3.01 Perform laser operation	2	5	7
		C3.02 Monitor laser operation	2	12	14
		C3.03 Perform kerf test	2	12	14

		C3.04 Perform post processing	1	6	7
		C3.05 Perform product inspection	1	6	7
	Sub Total		8	41	49
Total Duration (C)			19	65	84
D: Carry out Basic CNC Router Operations	D1: Prepare for CAM (Computer Aided Manufacturing)	D1.01 Install software	2	5	7
		D1.02 Design for CNC machining	2	12	14
		Sub Total	4	17	21
	D2: Prepare for CNC router operation	D2.01 Perform precheck	2	5	7
		D2.02 Mount job piece	1	6	7
		D2.03 Mount cutting tools	3	4	7
		D2.04 Set up machine	1	6	7
	Sub Total		7	21	28
	D3:Perform CNC router programming	D3.01 Program profile cutting	2	5	7
		D3.02 Program drilling	2	5	7
		D3.03 Program pocketing	2	5	7
		D3.04 Program engraving	2	5	7
	Sub Total		8	20	28
	D4: Execute and monitor CNC router operation	D4.01 Perform CNC operation	2	33	35
		D4.02 Perform post processing	2	12	14
		D4.03 Perform product inspection	2	12	14
	Sub Total		6	57	63
Total Duration (D)			25	115	140
E: Maintain Digital Fabrication Machines and Accessories	E1: Apply basic electrical theory	E1.01 Test conductor and insulator	1	2	3
		E1.02 Measure resistance	1	3	4
		E1.03 Measure voltage	2	2	4
		E1.04 Measure current	2	2	4
	Sub Total		6	9	15
	E2: Apply basic electronics theory	E2.01 Perform soldering	1	6	7
		E2.02 Test inductor	1	2	3
		E2.03 Test capacitor	1	2	3
		E2.04 Test diode	1	2	3
		E2.05 Test transistors	1	2	3
	Sub Total		5	14	19
	E3: Maintain 3D Printer	E3.01 Record maintenance logbook	1	2	3
		E3.02 Clean extruder	3	5	8
		E3.03 Lubricate moving parts	1	6	7
		E3.04 Replace extruder	1	6	7
		E3.05 Replace sensors	2	5	7
		E3.06 Replace control board	1	6	7
		E3.07 Assemble 3D printer	2	19	21
		E3.08 Update firmware	1	3	4
Sub Total		12	52	64	
	E4.01 Clean machine parts	1	6	7	

	E4:Maintain Laser Cutting Machine	E4.02 Lubricate rails and guides	1	6	7
		E4.03 Replace machine bed	1	6	7
		E4.04 Clean exhaust system	1	6	7
		E4.05 Perform beam alignment	2	12	14
		E4.06 Update firmware	1	2	3
		E4.07 Calibrate auto focus	1	6	7
	Sub Total		8	44	52
	E5:Maintain CNC Router Machine	E5.01 Perform machine inspection	1	6	7
		E5.02 Clean machine parts	1	6	7
		E5.03 Lubricate machine parts	1	6	7
		E5.04 Clean dust collector	1	6	7
	Sub Total		4	24	28
	Total Duration (E)		35	143	178
Total Duration		122	438	560	

Annex II: Module Recognition

This is to verify that

Mr/Ms.....

has completed module on

.....

Covering following learning outcomes:

1.
2.
3.

Instructor:

Head of the Department:

.....

.....

Signature:

Signature:

Date: / / (dd/mm/yyyy)
.....(dd/mm/yyyy)

Date: / /

Head of the Institute:

Trained Assessor (Institute)/Exam OC:

.....

.....

Signature:

Signature:

Date: / ... / (dd/mm/yyyy)

Date: / /(dd/mm/yyyy)

Annex IV: Lesson Plan
Lesson Plan

Course Title:		NC Level:
Module Code:		Duration:
Module Title:		
Learning Outcome:		
Skill/Task/Topic:		
Terminal Performance Objective:		
<i>(Note: Write narrative statement extracted from TPO of Task Sheet)</i>		
Enabling Objectives (Related knowledge):		
<i>By the end of the lesson learners will be able to:</i>		
- i) - ii) - iii)		
What (Content/Activity)	Who (T/L)	How (Methods/ Media)
Duration (Min.)	Questions	
<i>Introduction:</i>		
<i>Main body</i>		
<i>Conclusion</i>		
Projects/Problems:		

Instructional Resources Plan				
Skills/Task/Topic:				
No. of Trainees:				
Sl. No.:	Instructional materials/resources	Specifications	Qty.	Remarks
Prepared by :		Signature	Date:	
Revised by:		Signature	Date:	
Approved by:		Signature	Date:	

Task sheet

TS-1/4: Practical Plan			
Course Title:		N C Level:	
Module code:		Duration:	
Module Title			
Learning outcome			
Skills/Task Title:		Task no:	
Terminal Performance Objective: <i>Given:</i> <i>Cue:</i> <i>Who:</i> <i>What:</i> <i>Within:</i> <i>How well:</i> - - -			
Enabling Objectives (Related Skills): <i>By the end of a lesson, the learners will be able to:</i> i) ii) iii) iv)			
Activities	Who (T/L)	How (methods/ media)	Duration
Project/Assignment: 			

TS-2/4: Tool and Equipment required:							
<i>Sl no.</i>	<i>Particulars</i>	<i>Specifications</i>	<i>Qty.</i>	<i>Remarks</i>			
Training Materials required:							
<i>Sl no.</i>	<i>Particulars</i>	<i>Specifications</i>	<i>Qty.</i>	<i>Rate</i>	<i>Amount</i>	<i>Remarks</i>	
TS-3/4: Performance Guide							
Skill/Task:					Date:		
Directions: Use the following performance criteria to rate the learner. Check YES/NO to indicate whether the learner performed each step as indicated or not?							
Sl. No:	Steps					Yes	No
Note: Critical steps: All * marked steps should be carried out very carefully. For a quality performance guide, all items should be checked "YES"							

TS-4/4: Instruction and Drawing

General Instructions for Trainees

- i)
- ii)
- iii)
- iv)

Drawing (if any)

Safety Precaution

- i)
- ii)
- iii)

Prepared by:

Signature

Date:

Revised By:

Signature

Date:

Approved by:

Signature

Date:

Annex V: Course Plan
Institutes letter head and Logo

(Trade)YEAR PLAN- _____ **Semester** _____ **(Year)**

Trade: NC Level:			Schedule																																								Total Hours							
Module Code	Module Title	Learning Outcome	Feb.				March				April				May				June				July				Aug.				Sept				Oct.				Nov.											
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4												
OJT																																																		
Assessment and Certification																																																		

Prepared by:

Verified & Approved by:

Date:

Monthly/Weekly Plan

Month: Trade: Trainer:

Week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Week 01							
Week 02							
Week 03							
Week 04							
Week 05							

Developed by: Approved by:

Date



For more information please contact:

Technical Trainers Training and Resource Center (TTTRC), DWPSD

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