



GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
DIRECTORATE GENERAL OF TRAINING

COMPETENCY BASED CURRICULUM

CERTIFICATE COURSE ON

ADVANCED CNC MACHINIST 5-AXIS



NSQF LEVEL- 5

SECTOR : STRATEGIC MANUFACTURING

ADVANCED CNC MACHINIST 5-AXIS

Duration: 640 Hours

NSQF LEVEL - 5

(Version: 1.0)

Designed in 2020

Developed By

Ministry of Skill Development and Entrepreneurship

Directorate General of Training

Sectoral Trade Course Committee of Strategic Manufacturing Sector

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1. COURSE INFORMATION

1.1 GENERAL

The Directorate General of Training (DGT) under Ministry of Skill Development & Entrepreneurship offers a range of vocational training courses catering to the need of different sectors of the economy/ labour market. The vocational training programs of short term duration are intended for up skilling of NTC/ NAC pass out candidates. After passing out of the course, the trainee is awarded a competency based certificate approved by DGT.

In terms of Skilling and upskilling of ITI workforce in industries and Instructors and trainees in ITI ecosystem, the Advanced CNC Machinist 5-Axis Short term technical training (STT) under Strategic Manufacturing Sector is one of the high demand job roles which penetrates more employment and entrepreneurship delivered nationwide through a network of ITIs.

The Advanced CNC Machinist 5-Axis is of 640 Hours of duration and will be offered as add on course after completing CNC Machinist 3-Axis, Machinist or Operator Advanced Machine Tool under CTS/ATS.

In this course, During the Four Months duration, a candidate is trained on subjects- Professional Skill, Professional Knowledge related to CNC Machinist 5-Axis Job Role. The practical skills are imparted in simple to complex manner & simultaneously theory subject is taught in the same fashion to apply cognitive knowledge while executing task. The broad components covered under Professional skill subject are as below:

Module 1: In this module, the course contents covered are from Safety Precautions, Geometrical Dimensioning and Tolerances (GDT), Advanced Metrology & Coordinate Measuring Machine (CMM), Process Planning, Auto CAD – 3D, Basics of Manufacturing Module on CATIA and Master CAM.

Module 2: In this module, the course contents are covered are from CNC 5-Axis Machining Concepts, CNC 5-Axis Tool Management, 5-Axis CNC part Programming, 5-Axis CNC machine Operation, 5-Axis CNC machine Maintenance Concepts.

1.2 PROGRESSION PATHWAYS

- Can join industry as Master Skilled Craftsman and will progress further as Supervisor and can rise to the higher levels.
- Can join Crafts Instructor Training Scheme (CITS) in the trade for becoming instructor in ITIs.
- Further can grow and become an entrepreneur.

1.3 COURSE STRUCTURE

Table below depicts the distribution of training hours across various course elements :-

S No.	Course Element	Notional Training Hours
1.	Professional Skill (Trade Practical)	480
2.	Professional Knowledge (Trade Theory)	160
	Total	640

1.3 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude during the period of course through formative assessment and at the end of the training programme through summative assessment as notified by the DGT from time to time.

a) The Continuous Assessment (Internal) during the period of training will be done by Formative Assessment Method by testing for assessment criteria listed against learning outcomes. The training institute has to maintain an individual trainee portfolio as detailed in assessment guideline.

b) The pattern and marking structure is being notified by DGT from time to time. The learning outcome and assessment criteria will be the basis for setting question papers for final assessment.

c) Assessment will be evidence based comprising the following:

- Job carried out in labs/workshop/Field
- Answer sheet of assessment
- Viva-voce
- Participation and punctuality

Evidences of internal assessments are to be preserved until forthcoming examination for audit and verification by examining body.

d) The minimum pass percentage for skill test is 60%.

2. JOB ROLE

Brief description of Job roles:

Advanced CNC Machinist 5-Axis produces machined parts by programming, setting up, and operating different computer numerical control (CNC) machines, maintaining quality and safety standards, keeping records; maintaining equipment and supplies.

Advanced CNC Machinist 5-Axis makes the model of the job in Auto CAD 3D and generate the programs by using Master CAM or CATIA. Load the programs through post processor on various machines like 5-axis vertical machining center, 5-axis horizontal machining center, 5-axis CNC turn-mill center, etc., Studies drawings and measures out raw material required for the job to be machined. Study different dimensions of the job and required sequence of operations. Fastens raw material in chuck, jig or other fixture and respective tool or cutter, according to sequence of operation, on appropriate machine. Checks machine setting or sets it for stipulated machine operations. Controls flow of coolant (cutting lubricant). Start the program cycle and applies automatic controls to feed tool to metal for machining.

After machining, load the job on coordinate measuring machine (CMM) and checks all the dimensions and accuracies. Generates CMM printed report of measured dimensions and accuracies. Does process planning, tool and cutting parameters selection, programming, setup and operation for machining parts on 5-axis CNC machines. Maintains the CNC Machines by checking the alarms, oil levels, oil pressures, coolant level and also clean, oil the machine, routine and preventive maintenance. He should follow the organizational ethics and standards in order to fulfill the job role of Advanced CNC machinist 5-axis in all respects.

3. GENERAL INFORMATION

Name of the Trade	ADVANCED CNC MACHINIST 5-AXIS	
Course Code	DGT/8006	
Reference NCO - 2015	7223.5003, 7223.5005, 7223.6001, 7223.6003	
NSQF Level	Level 5	
Duration of Craftsmen Training	640 Hours	
Entry Qualification	<ol style="list-style-type: none"> 1. Passed in CNC Machinist 3-Axis OR 2. ITI pass in Machinist OR Operator Advance Machine Tool with One Year CNC Programming & Operation Experience OR 3. ATS in CNC Programmer Cum Operator with one year CNC Programming & Operation Experience. 	
Unit Strength (No. of Student)	20	
Space Norms	130 SQ. m	
Power Norms	20 KW	
Instructors Qualification for:		
(i) ADVANCED CNC MACHINIST 5-AXIS	<p>B. Voc. /Degree in Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field of CNC Programming and operation in 5 Axis.</p> <p>OR</p> <p>03 years Diploma in Engineering from AICTE/ recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field of CNC Programming and operation in 5 Axis.</p> <p>OR</p> <p>NTC/ NAC in above relevant trades with three years' experience in CNC Programming and Operation in 5 Axis.</p>	
List of Tools and Equipment	As per Annexure – I	
Distribution of training on hourly basis: (Indicative only)		
Total hours/Week	Trade practical	Trade theory
40	30	10

4. LEARNING OUTCOME

Learning outcomes are a reflection of total competencies of a trainee and assessment will be carried out as per the assessment criteria.

4.1 LEARNING OUTCOMES

1. Exhibit different workshop safety measures and use PPE & First aid kit.
2. Measure geometrical accuracies and surface finish of the component using Basic Measuring Instruments and Co-ordinate Measuring Machine (CMM).
3. Prepare Process plan and sequence of operations.
4. Make 3D Drawings in AutoCAD
5. Perform work on basic CATIA machining
6. Create and analyse programs in Master CAM and post process to CNC machine.
7. Understand the elements of CNC 5-Axis Machines and their Tool Management
8. Write basic part programs and execute the part programs for different operations on CNC 5-Axis machining centres.
9. Execute Project work on 5-Axis CNC Turn Mill and Machining Centers.
10. Perform 5-Axis CNC Maintenance

5. SYLLABUS

Course: Advanced CNC Machinist 5-Axis Index - Contents			
Sl. No	Topic	Professional Knowledge (Trade Theory) in Hours-160	Professional Skill (Trade Practical) In Hours - 480
Module 1: Two Months			
1.	Safety Precautions	5	15
2.	Geometrical Dimensioning and Tolerances (GD&T)	10	30
3.	Advanced Metrology & Coordinate Measuring Machine (CMM)	10	30
4.	Process Planning	5	15
5.	Auto CAD – 3D	20	60
6.	Basics of Manufacturing Module on CATIA	10	30
7.	Master CAM	25	75
Module 2: Two Months			
1.	CNC 5-Axis Machining Concepts	10	30
2.	CNC 5-Axis Tool Management	10	30
3.	5-Axis CNC part Programming	15	45
4.	5-Axis CNC Operation and Project Work	30	90
5.	5-Axis CNC Maintenance Concepts	10	30

SYLLABUS – ADVANCED CNC MACHINIST 5-AXIS

Duration: 640 Hours

Duration	Reference Learning outcome	Professional Skills (Trade Practical)	Professional Knowledge (Trade Theory)
Professional Skill:15 Hours Professional Knowledge: 05 Hours	Exhibit different workshop safety measures and use PPE & First aid kit	<p>1. Safety Precautions:</p> <ol style="list-style-type: none"> 1. Follow Health, Safety and Environment guidelines, Legislations & regulations as applicable. And dispose the waste material as per procedure. 2. Ensure Basic injury prevention, Basic first aid, Hazard identification and avoidance, safety signs for Danger, Warning caution& personal safety. 3. Use Preventive measures for Electrical accidents & steps to be taken in such accidents. 4. Use of Fire extinguishers. 5. Basic Life support training-Be able to perform DRSABCD: D: Check for danger, R: Check for Response, S: Send for help, A: Open the Airway, B: Check for normal breathing, C: Perform CPR (Cardio Pulmonary Resuscitation), D: Attach Defibrillator/Monitor as soon as available. <p>(30 Hours)</p>	<p>Safety Precautions:</p> <ol style="list-style-type: none"> 1. Introduction of First Aid. 2. Operation of electrical mains. 3. Effective usage of PPEs. 4. Response emergencies e.g.: power failure, fire, and system failure. 5. Introduction to 5S concept & its application. Importance of 5S implementation. 6. Basic Life Support (BLS): Basic Life Support (BLS) techniques for drowning, choking, electrocution, neck and spinal injury, including CPR (Cardio Pulmonary Resuscitation). <p>(10 Hours)</p>
Professional Skill: 30 Hours Professional Knowledge:	Measure geometrical accuracies and surface finish of the component using Basic	<p>2. Geometrical Dimensioning and Tolerances (GD&T):</p> <ol style="list-style-type: none"> 1. To Check perpendicularity and Parallelism on components. 2. To check runout and concentricity on cylindrical jobs. 	<p>Geometrical Dimensioning and Tolerances (GDT):</p> <ol style="list-style-type: none"> 1. Introduction to dimensioning and tolerances. 2. Introduction to geometrical accuracies such as parallelity,

10 Hours	Measuring Instruments and Co-ordinate Measuring Machine (CMM).	<ol style="list-style-type: none"> To check surface finish using surface roughness Tester. To check straightness and flatness. Verify the given job, whether the measured dimensions are within specified tolerance zone. <p>(30 Hours)</p>	<p>perpendicularity, concentricity etc.,</p> <ol style="list-style-type: none"> Surface texture; Waviness, Roughness, Primary, Secondary textures, Symbols and Values and Ra, Rz values. Study for flatness and straightness. <p>(10 Hours)</p>
Professional Skill: 30 Hrs Professional Knowledge: 10 Hrs		<p>3. Advanced Metrology & Coordinate Measuring Machine (CMM):</p> <ol style="list-style-type: none"> Usage of different advanced measuring instruments. (7 hrs) Use of CNC CMM in Checking different dimensions such as centre distances, bores, depth, Linear and Angular measurement, Accuracies such as parallelity, Perpendicularity, concentricity etc.(8 hrs) Report generation of CNC CMM Measurements. (8 Hrs) Check dimensions by using Optical Profile projector. (7 hrs) 	<p>Advanced Metrology & Coordinate Measuring Machine (CMM):</p> <ol style="list-style-type: none"> Introduction to all geometrical measurements definition and descriptions. Description of different profiles. Surface texture; Waviness, Roughness, Primary, Secondary textures, Symbols and Values. Ra, Rz values. Profile projector its applications Introduction to CNC-CMM and its applications. Care and maintenance of measuring instruments. <p>(10 hrs)</p>
Professional Skill:15 Hrs Professional Knowledge: 05 Hrs	Prepare Process plan and sequence of operations.	<p>4. Process Planning:</p> <ol style="list-style-type: none"> To understand the drawing To identify the sequences of operations. Proper selection of cutting tools and work holding devices /Fixtures. To prepare the process sheets for components. <p>(15 Hours)</p>	<p>Process Planning:</p> <ol style="list-style-type: none"> Importance of process planning Understanding the process planning parameters Understanding the sequences of operation along with machines, tools, work holding devices/ fixtures and measuring instruments required, setup time and operation time <p>(05 Hours)</p>
Professional Skills: 60 hrs.	Make 3D Drawings in AutoCAD	<p>5. Auto CAD – 3D:</p> <ol style="list-style-type: none"> Making of 3D Sketch. Dimensioning. 	<p>Auto CAD – 3D:</p> <ol style="list-style-type: none"> Basic Orientation Selection of commands in 3D.

<p>Professional Knowledge: 20 hrs.</p>		<ol style="list-style-type: none"> 3. Draw Isometric views. 4. Creating 3D Models. 5. Rendering of 3D Models. 6. Creating 3D Drawings. 7. Working with Layers. 8. Mesh & Files in AutoCAD. 9. GD&T Features. 10. Generation of coordinates. 11. Creating Templates, Title blocks. 12. Plotting & Publishing. 13. Project Work. <p>(60 Hours)</p>	<ol style="list-style-type: none"> 3. Learning of 3D drawings. 4. Use of short cut Commands. 5. Layers concept. 6. File Formats-IGES & STEP File. 7. Project work. <p>(20Hrs)</p>
<p>Professional Skills: 30 Hours. Professional Knowledge: 10 Hours.</p>	<p>Perform work on basic CATIA machining</p>	<p>6. Basics of Manufacturing Module on CATIA:</p> <ol style="list-style-type: none"> 1. Select the tools for manufacturing. 2. Creating Cutting parameters and verify 3. Applying Cutter compensation 4. Methods to follow Non-cutting move 5. Working on Lathe & Prismatic machining operations. 6. Working on Surface machining (3 Axis) operations 7. Method of Probing operations. 8. Analyse and modify the tool path 9. Working on various 5-axis machining operations- profile contouring and iso-Parametric. 10. Project work <p>(30 Hours)</p>	<p>Basics of Manufacturing Module on CATIA:</p> <ol style="list-style-type: none"> 1. Graphical user interface 2. Analysing manufacturing part 3. Coordinate systems 4. Turning 5. Turn Mill centre 6. Milling - Prismatic Machining – 3- Axis & 5- Axis, 7. Surface Machining – 3 Axis, 8. Multi Axis Machining – 4 & 5 Axis. 9. Guidance on project work <p>(10 Hours)</p>
<p>Professional Skills: 75 hrs. Professional Knowledge: 25 hrs.</p>	<p>Create and analyse programs in Master CAM and post process to CNC machine.</p>	<p>7. Master CAM:</p> <ol style="list-style-type: none"> 1. Importance of 3D models 2. Selection of tools for manufacturing. 3. Methods of machining. 4. Sequence of operations. 5. Simulation 	<p>Master CAM:</p> <ol style="list-style-type: none"> 1. Importance of Master CAM 2. Introduction of 2D Sketch & 3D Surface & Solid Models. 3. Manufacturing machining selection (5 Axis) 4. Tool selection.

		<ol style="list-style-type: none"> 6. Generation of Programme/Post processor (5 Axis) 7. Sending program to the machining. 8. Machining side Execute programme 9. Import the Model 2D or 3D. 10. Write, enter, and Debug programs 11. File format - STL, IGES, Export, Import Files. 12. Project work (75 Hours.) 	<ol style="list-style-type: none"> 5. Tool path movements 6. Selection of Speed, Feed, Depth of cut, Work Offsets & Tool offsets. 7. Manufacturing procedure. 8. Use short cuts to improve productivity 9. Guidance on project work <p>(25 Hours)</p>
<p>Professional Skill:30 Hours.</p> <p>Professional Knowledge: 10 Hours.</p>	<p>Understand the elements of CNC 5-Axis Machines and their Tool Management</p>	<p>8. CNC 5-Axis Machining Concepts:</p> <ol style="list-style-type: none"> 1. Demo of various types of CNC 5-Axis machines 2. Demo of different operating modes.Ex: Jog, MDI, MDA, Auto, INC, Hand wheel(MPG), Reference point, Diagnostics 3. Demonstration elements of CNC machine like operator control panel, different axes, spindle, ATC/Tool Turret in case of lathe, Hydraulic power pack, Central Lubrication system, Coolant and Chip disposal system, Counter balance of vertical axis etc. <p>(30Hours)</p>	<p>CNC 5-Axis Machining Concepts:</p> <ol style="list-style-type: none"> 1. Comparison between CNC 3-Axis and CNC 5-Axis 2. Concepts and features of CNC 5-Axis. 3. 5-Axis identification 4. Co-ordinate system. 5. Different manufacturers of CNC 5-Axis machines and controls. <p>(10 Hours)</p>
<p>Professional Skill: 30 hrs.</p> <p>Professional Knowledge: 10 hrs.</p>		<p>9. CNC 5-Axis Tool Management:</p> <ol style="list-style-type: none"> 1. To understand the tools and their Management. 2. Setting of component / work pieces by using fixtures. 3. Practice the cutting parameters. 4. Create solid model through Master CAM / CATIA. <p>(30 Hours)</p>	<p>CNC 5-Axis Tool Management:</p> <ol style="list-style-type: none"> 1. Cutting Tools and Cutting parameters. 2. Tool Management of high speed tooling. 3. Understand the concept of jigs and fixtures. <p>(10 Hours)</p>

<p>Professional Skill: 45 hrs.</p> <p>Professional Knowledge: 15 hrs.</p>	<p>Write basic part programs and Execute the part programs for different operations on CNC 5-Axis machining centres.</p>	<p>10. 5-Axis CNC Programming:</p> <ol style="list-style-type: none"> 1. Practical demo on input of part program on simulator 2. Simulation of part program on Simulator. 3. Input of part program on machine. 4. Simulation of program on machine. 5. Setting of Tool and work off-sets on the machine. 6. Practice exercises. 7. Operation and familiarization on CNC 5-Axis machining centres. 8. Executing the part program in auto Single Block and auto continuous mode. 9. Practice on CNC machining centres for different operations of production / job work. 10. Practice of contour program for different profiles on CNC simulation software. 11. Understanding the probing concepts (45hrs) 	<p>5-Axis CNC Programming:</p> <ol style="list-style-type: none"> 1. Part Program structure, Block formation and different functional Alphabets used in programming. Ex: N, S, T, etc, 2. Preparatory and miscellaneous codes used in the CNC programming.(G and M codes). 3. Explaining about work off-sets and Tool Off-sets. 4. Writing of simple program by taking different offsets. 5. Make model in CAM software. 6. Generate the program and upload to the 5-Axis Machine / Simulator 7. ISO designation of CNC cutting Tools. 8. Latest trends of CNC cutting tools. 9. Understanding Sinumeric and Fanuc controls 10. Understanding the Concept Profile programming for different profiles generated in CAM model. <p>(15 Hours)</p>
<p>Professional Skills: 90 hrs.</p> <p>Professional Knowledge: 30 hrs.</p>	<p>Execute Project work on 5-Axis CNC Turn Mill and Machining Centers.</p>	<p>11. 5-Axis CNC Operation and Project Work:</p> <ol style="list-style-type: none"> 1. Continuous Practice on 5-Axis CNC Machining Centres and CNC Turn-Mill Centre. 2. Writing of work diary by every individual. 3. Recording daily progress instantly in the diary. 4. Project identification. 5. Execution and completion of project work. 	<p>5-Axis CNC Operation and Project work:</p> <ol style="list-style-type: none"> 1. Guidance on project work. 2. Understanding of different machines and control systems available in Industry. 3. Preparation of part programs for live/production jobs. 4. Understanding probing. (Tool Probe and Job probe) <p>(30 Hours)</p>

		<p>6. Preparation of project work report along with inspection report.</p> <p>7. PPT presentation on Project.</p> <p>8. Evaluation of Project work. (90 hrs)</p>	
<p>Professional Skills: 30 Hours.</p> <p>Professional Knowledge: 10 Hours.</p>	<p>Perform 5-Axis CNC Maintenance.</p>	<p>12. 5-Axis CNC Maintenance Concepts:</p> <ol style="list-style-type: none"> 1. Practice on routine maintenance. 2. Periodic checking of centralised lubrication system. 3. Hydraulic oil level. Checking of complete Hydraulic system such as Oil level, different pressures (System, Chuck, Spindle, Tool etc) 4. Checking of pneumatic control system such as Air pressure, Quality of Air, Filter, Regulator & Lubricator, Dryer etc. 5. Clearing alarms. 6. Setting of machine parameters. (30 Hours) 	<p>5-Axis CNC Maintenance Concepts:</p> <ol style="list-style-type: none"> 1. Normal procedure followed for maintenance of machine tool in the shop floor. 2. Difference between breakdown and preventive maintenance, Its importance in productivity. 3. Preventive Maintenance. 4. Importance of centralized lubrication system. 5. Hydraulics & pneumatics and their uses 6. Different alarm messages and trouble shootings. 7. Observation of abnormalities such as noise and over temperature of machine elements. (10 Hours)
Examination			

6. ASSESSMENT CRITERIA

LEARNING OUTCOMES	ASSESSMENT CRITERIA
1. Exhibit different workshop safety measures and use PPE & First aid kit.	Demonstrate Basic injury prevention and use of basic first aid kit
	Demonstrate waste material disposal as per procedure.
	Exhibit use of Preventive measures for Electrical accidents
	Demonstrate use of Fire extinguishers
2. Measure geometrical accuracies and surface finish of the component using Basic Measuring Instruments and Co-ordinate Measuring Machine (CMM).	Check perpendicularity and Parallelism of given components
	check runout and concentricity of given cylindrical jobs.
	check surface finish using surface roughness Tester.
	check straightness and flatness using Autocollimeter.
	Measure the given job to verify dimensions are within specified tolerance
	Check different dimensions and parameters of a given component using CNC CMM
3. Prepare Process plan and sequence of operations.	Check dimensions of a given component using Optical Profile projector.
	Study the drawing
	Plan for the desired sequences of operations
	Plan for required cutting tools and work holding devices /Fixtures
4. Make 3D Drawings in AutoCAD	prepare the process sheets for operations on the components as per the drawing
	Study the component and make 3D sketch with dimension
	Draw Isometric views with Layers , Mesh & Files in AutoCAD
	Create and render 3D models and create 3D drawing
5. Perform work on basic CATIA machining	Plot & Publish the drawing with GD&T Features, Templates and Title blocks.
	Study the drawing and Select the tools for machining
	Create cutting parameters and apply cutter compensation
	Demonstrate working on Lathe, Prismatic machining operations and Surface machining (3 Axis) operations
6. Create and analyse programs in Master CAM and post process to CNC machine.	Demonstrate working on 5-axis machining operations- profile contouring and Iso-Parametric.
	Study the drawing and ascertain methods of machining
	Select tools for manufacturing and prepare Sequence of operations
	Generate Programme/Post processor (3- Axis) and Simulate it
7. Understand the elements of CNC 5-Axis Machines and their Tool	Write, enter, and Debug programs onto machine
	Illustrate various types of CNC 5-Axis machines
	Demonstrate elements of CNC 5-Axis machine
	Exhibit different operating modes

Management	Set tools and work pieces by using fixtures.
	Create solid model through Master CAM / CATIA.
8. Write basic part programs and execute the part programs for different operations on CNC 5-Axis machining centres.	Demonstrate input of part program on simulator and run part program
	Demonstrate input of part program on CNC 5-Axis machining centres and run part program
	Exhibit setting of Tool and work off-sets on the machine
	Perform different operations of production / job work on CNC 5-Axis machining centres.
9. Execute Project work on 5-Axis CNC Turn Mill and Machining Centers.	Study project drawing and write program on required operations for 5-Axis CNC Turn Mill and machining centers.
	Input program on machine and demonstrate setting of Tool and work off-sets on the machine.
	Execute the program on 5-Axis CNC Turn Mill and machining centres for different operations to complete the project work
	Check the dimensions of produced component and assemble them as per project drawing.
	Prepare project work report
10. Perform 5-Axis CNC Maintenance	Demonstrate routine maintenance and checking of lubrication.
	Demonstrate checking of Hydraulic oil level and Hydraulic system pressure.

LIST OF TOOLS & EQUIPMENT			
ADVANCED CNC MACHINIST 5-AXIS			
S No.	Name of the Tools and Equipment	Specification	Quantity
A. TRAINEES TOOL KIT			
1.	Screw drivers box	Standard Specification	3sets.
2.	Long nose plier	150mm.	5 nos.
3.	Combination plier	150mm.	5 nos.
4.	Adjustable spanner or side wrench		5 nos.
5.	Hack saw frame adjustable	250 - 300mm. with blades	5 nos.
6.	Flat file	200mm.	5 nos.
7.	Triangular File	150 mm.	5 nos.
8.	Half round file	150 mm	5 nos.
9.	Square file	150 mm	5 nos.
10.	Ring spanner set	Standard specifications metric	2 sets
11.	Box spanner set	Standard specifications metric	2 sets
12.	Hammer cross peen	500 gms. With handle	5 nos.
13.	Hammer small	250gms. With handle	5 nos.
14.	Grease Gun	500ml	5 nos.
B.SHOP OUTFIT & MEASURING INSTRUMENTS			
(i) List of Tools & Accessories			
15.	Slip gauge box	M45 Specifications	2 nos.
16.	Vernier Caliper	0-300mm	5 nos.
17.	Micrometer	0-100mm	5 nos.
18.	Height Gauge	0-300mm	5 nos.
19.	Depth Gauge	0-300mm	5 nos.
20.	Bore Gauge	0-100mm	5 nos.
21.	Dial gauge Stand	Standard	5 nos.

22.	Magnetic Stand	Standard	5 nos.
23.	Dial Indicator	Least count 0.01mm, range upto 10mm	5 nos.
24.	Surface roughness tester	Standard specifications-portable	2 no.
25.	Hardness Tester	Standard specifications-portable	2 no.
26.	Vernier bevel protractor	Least count 5 min.	3 nos.
27.	Combination Set	Standard specification	3 Sets.
28.	Sine bar	250mm	2 Nos.
29.	Sine Centre	300mm	2 Nos.
30.	Gear tooth Vernier calliper	150mm, Least count 0.02mm	2 Nos.
31.	V blocks, Parallel blocks	Standard specifications	10 Sets.
32.	Tool Pre setter	<p>Tool Pre setter Specifications:</p> <ul style="list-style-type: none"> * Measuring dia. (X axis) - Upto 320 mm * Measuring length (Z axis)- 400 mm ; * High grade Cast Iron Base& Column ; * Spindle taper : ISO 40 ; * Spindle rotation on Ultra precision bearings * Movement on Linear Motion guides and with Ball screws ; * 2 Axis DRO with Linear encoder with Least count of X axis- 0.001mm and Z axis 0.005 mm and with memory of storing data of 100 tools ; * Tool edge detection by Projector and Dial Indicators of 0.001mm for X axis and 0.010 mm for Y axis ; * Pneumatic tool clamping. * Compare Master gauge for gauge plane calibration & test mandrel for diameter setting. 	1 Set
(ii) List of Equipments			
33.	Coordinate Measuring Machine (CMM)	<ul style="list-style-type: none"> • Measurement: X Axis 700 mm (Minimum), Y Axis 1000 mm (Minimum), Z Axis 600 mm (Minimum), • Accuracy: + 7 Microns and as per ISO10360-2 Standard • Resolution 0.1 micrometer 	1 No.

		<p>(Maximum)</p> <ul style="list-style-type: none"> Granite Table for providing a durable & secure surface for parts. Ceramic Guide ways or special aluminum alloy offering rigidity & stability against temperature changes, moisture & other contamination. Air bearing guide system on all axes. All the 3 axes should be supported by 4 side Air Bearings. Computer independent standard panel having dual graduated control joystick for easy and precise movement of all 3 axes. Measurement facility with manual and CNC(auto) mode. Variable Speed control in CNC mode. With Computer, software and standard accessories <p>The scope of supply includes:</p> <ul style="list-style-type: none"> 3 axes coordinate measuring machine Probing system Ceramic calibration sphere Work station based computer system Application software Installation and commissioning Training of personnel Manuals for operation and maintenance. 	
34.	AUTOCAD	AUTOCAD-2020 or latest Education Version -2D.	20 Licence – Per Batch of 20 students.
35.	Master Cam – 5 Axis Machining	Master CAM 2020 or latest – 5 Axis Machining - Education Version (Manufacturing Module)	20 Licence – Per Batch of 20 students.

36.	CATIA V5	CATIA V5 2020 or latest Education Version	20 Licence – Per Batch of 20 students.
37.	Work Stations	OS – Windows 10. With 64 bit professional. Processor: Intel/AMD 64 Bit processor, 3.2 GHZ Graphics Card: NVIDIA QUADRO 4 GB HDD: 500 GB RAM: 16 GB Monitor – 21 Inch Cabinet with SMPS. Mouse, Key Board. MS office latest version	20 work stations Per a batch of 20 students. 20 MS Office License
38.	Internet Connection-FTTH	100 mbps minimum	1 No.
39.	Local Area Network (LAN) with 24 port Switch	24 port LAN Switch, 4U Rack Wall mount and Cabling layout for 20 I/O ports, RJ-45 cables with connectors for 20 workstations.	1 LAN system
40.	Class Room Tables / Benches	Specifications As per requirement	20 Nos.
41.	Class Room Chairs	Specifications As per requirement	20 Nos.
42.	Instructor Chair	Specifications as per requirement	1 No.
43.	Instructor Table	Specifications as per requirement	1 No.
44.	Interactive board with accessories		1 no.
45.	LCD Projector with accessories		1 no.
46.	Uninterrupted Power Supply (UPS)	5KVA, 3 hours Backup time.	1 nos.
47.	Multi-Function Device (MFD) Printer	Printer, Scanner, Copier With Accessories	1 no.
48.	Computer Tables	As per requirement	20 nos.
49.	Computer Chairs	As per requirement	20 nos.
50.	White Board	1200mm x 900mm	1 no.
SHOP MACHINERY			
51.	CNC Machines (5-Axis)		
	(a) CNC Vertical Machining Centre	• Tilting rotary Table size: dia 400	1 No.

		<ul style="list-style-type: none"> • Max. Load on Table: 200 Kgs. • A-axis Tilting range: -90 to +30 degree • C-Axis Tilting range: 360 degree continuous. • A & C Traverse rate: 10 rpm • x-axis stroke 600mm • y-axis stroke 400 mm • z-axis stroke 400 mm • Rapid traverse of Linear axis: 20 m/min. • spindle taper: ISO 40 / BT 40 • Spindle power: 20 kW • Spindle speed: 8000 rpm • Automatic Tool Changer (ATC): 20 tools • Control System: Siemens / Fanuc / Equivalent. • Positional Accuracy / repeatability as per VDI/DGQ 3441.: X, Y, Z-Axis 0.008 / 0.004mm; • Standard toolings along with adopters 1 set. • Standard Accessories 1 set. • Tool and Work-holding devices -1 Set. • Standard Tools-1 Set. 	
	<p>(b) CNC Turn-mill Centre</p>	<ul style="list-style-type: none"> • Swing over bed 460mm • Distance between Centres 400mm • Maximum turning dia between centres 250mm • Max. Turning dia (Chucking) 300mm • Spindle nose / bore A2-6 / 53 mm • Socket tapper metric 60 • Power- 7.5kW • Speed Range 10 to 4000rpm • Cross slide travel x-axis 250mm • Saddle travel (450mm) 	<p>1 No.</p>

		<ul style="list-style-type: none"> • Slide travel +/- 30mm • Rapid traverses – X 12m/min, Y-5m/min., Z-20m/min. • Turret type VDI 40 • Number of Tools 12. • Tools shank size 25 x 25mm • Max. Bore / size 40mm • C-axis Maximum Speed 40rpm • Positional accuracy / repeatability 20/10 arc seconds • Tailstock quill dia / stroke is 90 dia / 120mm • Quill taper MT4. • CNC System Siemens / Fanuc. • Positional Accuracy / repeatability as per VDI/DGQ 3441. X-Axis 0.008/ 0.004mm. Z-Axis 0.008/ 0.004mm. • Standard toolings along with adopters 1 set. • Standard Accessories 1 set. • Tool and Work-holding devices -1 Set. • Standard Tools-1 Set. 	
SHOP FLOOR FURNITURE AND MATERIALS			
52.	Work Bench Tables with Vice	Standard Size	20 Nos.
53.	Raw Material for jobs	AS per Raw materials standard specifications	As required
54.	Fire Extinguishers	2Kg CO2 / Powder 5 Kg CO2 / Powder	As required
55.	First Aid Kit with Accessories	HE*Gloves, w/opowder, nitr, M, disp, box/100-1 no. Tape, adhesive, Z.O., 2.5cmx5m -2 nos. Tape, adhesive, Z.O, perforated, 10cmx5m – 1 no. Bandage, elastic, 7.5cmx5m, roll -2 nos. Bandage, gauze, 8cmx4m, roll -10 nos.	As required

		<p>First Aid bag, UNICEF, blue, 410x280x170mm-1 no.</p> <p>Compress, gauze, 10x10cm, n/ster/PAC-100 -1 no.</p> <p>Compress, paraffin, 10x10cm, ster/BOX -10 -1 no.</p> <p>Compress, gauze, 10x10cm, ster/PAC-5 -10 nos.</p> <p>Pin, safety, medium size/PAC-12 -1 no.</p> <p>Soap, toilet, bar, approx. 110g, wrapped -1 no.</p> <p>Blanket, survival, 220x140cm -1 no.</p> <p>Towel, huck, 430 x 500mm -1 no.</p> <p>Forceps, dressing, standard, 155mm, str-1 no.</p> <p>Forceps, artery, Kocher, 140mm, str -1 no.</p> <p>Scalpel blade, ster, disp, no.22 -1 no.</p> <p>Scissors, Deaver, 140mm, str, s/b -1 no.</p> <p>Ibuprofen 200mg tabs/PAC-100 m-1 no.</p> <p>Tetracycline eye ointment 1%/TBE-5g -1 no.</p> <p>Chlorhexidine conc. sol. 5%/BOT-100ml -1 no.</p>	
56.	PPE Kit	All Protective equipments with accessories	As required

8. ANNEXURE-II

The DGT sincerely acknowledges contributions of the Industries, State Directorates, Trade Experts, Domain Experts and all others who contributed in designing/ revising the curriculum. Special acknowledgement is extended by DGT to the following expert members who had contributed immensely in this curriculum.

List of Expert Members contributed/ participated for finalizing the course curriculum of ADVANCED CNC MACHINIST 5-AXIS.			
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3.	N. SRINIVASA RAO,, PRINICIPAL	GOVT. ITI, Pathanchervu, Hyderabad	Member
4.	K. B. S. NARAYANA, TRAINING OFFICER	CSTARI, Kolakota	Member
5.	S. GOPALAKRISHNA, ASSISTANT MANAGER	NIMI, Chennai	Member
6.	Ms. SHALINI SINGH, COO,	NSDC, New Delhi.	Member
7.	1. Dr. MRM Babu, Director, Distinguished Scientist. 2. BVSS Prasad, General Technical Manager. 3. A. Purushottam, Scientist F, 4. Shri. DevendraBhardwaj, Deputy Gen, Manager, Production & Procurement. 5. Shri. Ravindra Reddy, Addl. Gen. Manager-Manufacturing. 6. Dr. G. Sridhar, Chief Manager Methods. 7. Shri. W. NarasimhaRao, DGM-MS 8. Shri. M. Mruthayumjayudu, Senior DGM (Corporate Learning Development Centre)	1. ASL-DRDO, Hyderabad. 2. HMT, Hyderabad 3. ASL-DRDO, Hyderabad. 4. Ordnance Factory Medak 5. Bharat Dynamics Limited, Hyderabad 6. Hindustan Aeronautics Limited, Hyderabad. 7. BEL, HYDERABAD 8. Electronics Corporation of India Limited(ECIL), Hyderabad	Member
8.	1. K. MAHENDAR, Deputy Director. 2. A. A. MAHISHI, Deputy Director	NSTI, BENGALURU NSTI (V), HYDERABAD	Member

	3. G P. VIJAYAKRISHNA, Asst. Director	NSTI (V), HYDERABAD	
9.	N. P. BANNIBAGI, Asst. Director.	NSTI-R, HYDERABAD.	Member

List of Industry Experts involved in the preparation of Syllabus of CNC MACHINIST 5-Axis.

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10.	Sh. CH SambasivaRao, JWM (Retd)	Ordnance Factory, Medak	Member
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12.	Sh. Lakshmi Narayana, Asst. Manager	EDS Systems, Hyderabad	Member
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15.	Sh. Murali Krishna, Training Officer	NSTI (V), Hyderabad	Member
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VETTING EXPERTS – Advanced CNC Machinist 5-Axis

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5.	Sh. Shivapal Singh, Project Director	DRDL-DRDO Hyderabad	

6.	Sh.Shiva Dayal B., Scientist -G, Group Director Engineering	DRDL-DRDO Hyderabad	
7.	Sh.KiranPolamuri, Scientist G, Technology Director, Engineering	DRDL-DRDO Hyderabad	
8.	Sh.Murty T. S., Retd. Principal Director	OFIL, Avadi, Chennai	
9.	Sh.Suryanarayana, AGM - Engineering Services (Retd.)	MIDHANI, Hyderabad	
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37.	Sh.Ramesh Krishna, CEO	Ramesh Krishna Engineers Pvt. Ltd.	
38.	Sh.RangaRaju, CEO	Vem Technologies Pvt Ltd, Hyderabad	
39.	Sh.M Siva Rama Prasad, CEO	Tech Aero Devices, Hyderabad	
40.	Sh.Bhaskar, CEO	Sun Fab Coach Builders & Industries, Hyderabad	
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43.	Thamizharasan, Retd (Director)	NSTI, Kolkota	