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

COMPETENCY BASED CURRICULUM

ADDITIVE MANUFACTURING (3D PRINTING) TECHNICIAN

(Duration: One Year)

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL – 3.5

SECTOR – CAPITAL GOODS & MANUFACTURING

Directorate General of Training

ADDITIVE MANUFACTURING (3D PRINTING) TECHNICIAN

(Engineering Trade)

(Revised in 2024)

Version: 3.0

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL – 3.5

Developed By

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1. COURSE INFORMATION

During the one-year duration of Additive manufacturing Technician (3D Printing) trade a candidate is trained on professional Skill, professional Knowledge, and Employability Skill related to job role. In addition to this a candidate is entrusted to undertake project work and extracurricular activities to build up confidence. The broad components covered in one year duration are as below:

The trainee learns about safety and environment, use of fire extinguishers, artificial respiratory resuscitation to begin with. They get the idea of basic computer operation to generate 3D model. This includes construction of geometrical figures using drawing instruments, procedure to prepare a drawing sheet as per SP-46:2003. After becoming familiar with basic drafting terminology, students begin to develop multi-view drawings and learning about projection methods, auxiliary views and section views. Lettering, tolerance, metric construction, technical sketching and orthographic projection, isometric drawing, oblique and perspective projection are also covered. Generate detailed and assembly views with dimensions, annotations, in 3D Modeling software, print preview to plot in .dwg and .pdf format. In Manufacturing Technology includes making job as per specification with power tool operation, different complex assembling and fitting, fastening, lapping, making gauges and check for functionality. In electrical & electronics part trainees identify the basic functioning of electrical and electronics equipment used in industrial applications. In addition to maintenance work of 3D printing machine they perform to check the desired accuracy of the components.

The Trainees learn to design and develop prototype/ end use product for Additive Manufacturing (AM) viz., Bracket/ Lever, Clamp, Spur Gear, threaded components etc. by extrusion (FFF Technology) and photo-polymerization (SLA)/ PLA technology. They learn to design and analysis of fixtures and various composite materials, aesthetic models and suggest optimization process. In addition, they carry out maintenance i.e. disassembling and assembling of AM machines, application of process algorithm of Slicing Software, application of post processing techniques to finish job, scanning techniques and processing of scan data to create parametric model.

2. TRAINING SYSTEM

2.1 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 / labor market. The Vocational Training Programmes are delivered under the aegis of the Directorate General of Training (DGT). Craftsman Training Scheme (CTS) with variants and Apprenticeship Training Scheme (ATS) are two pioneer Programmes of DGT for propagating vocational training.

CTS courses are delivered nationwide through network of ITIs. The course 'Additive Manufacturing Technician (3D Printing)' is of one-year duration. It mainly consists of Domain area and Core area. The Domain area (Trade Theory and Trade Practical) imparts professional skills and knowledge, while Core area (Employability Skills) imparts requisite core skill, knowledge and life skills. After passing out of the training program, the trainee is awarded National Trade Certificate (NTC) by DGT which is recognized worldwide.

Trainee broadly needs to demonstrate that they are able to:

- Read and interpret technical parameters/ documentation, plan and organize work processes, identify necessary materials and tools.
- Perform tasks with due consideration to safety rules, accident prevention regulations and environmental protection stipulations.
- Apply professional knowledge & employability skills while performing the job and modification & maintenance work.
- Document the technical parameters related to the task undertaken.

2.2 PROGRESSION PATHWAYS

- Can join industry as Technician and will progress further as Senior Technician, Supervisor and can rise up to the level of Manager.
- Can become Entrepreneur in the related field.
- Can join Apprenticeship Programmes in different types of industries leading to a National Apprenticeship Certificate (NAC).
- Can join Crafts Instructor Training Scheme (CITS) in the trade for becoming an instructor in ITIs.
- Can join Advanced Diploma (Vocational) courses under DGT as applicable.

2.3 COURSE STRUCTURE

Table below depicts the distribution of training hours across various course elements during a period of one-year:

S No.	Course Element	Notional Training Hours
1	Professional Skill (Trade Practical)	840
2	Professional Knowledge (Trade Theory)	240
3	Employability Skills	120
	Total	**1200**

Every year 150 hours of mandatory OJT (On the Job Training) at nearby industry, wherever not available then group project is mandatory.

On the Job Training (OJT)/ Group Project	150
Optional Courses (10th/ 12th class certificate along with ITI certification or add on short term courses)	240

Trainees of one-year or two-year trade can also opt for optional courses of up to 240 hours in each year for 10th/ 12th class certificate along with ITI certification, or, add on short term courses.

2.4 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 individual *trainee portfolio* as detailed in assessment guideline. The marks of internal assessment will be as per the formative assessment template provided on www.bharatskills.gov.in

b) The final assessment will be in the form of summative assessment. The All India Trade Test for awarding NTC will be conducted by Controller of examinations, DGT as per the guidelines. The pattern and marking structure is being notified by DGT from time to time. **The learning outcome and assessment criteria will be basis for setting question papers for final**

assessment. The examiner during final examination will also check individual trainee's profile as detailed in assessment guideline before giving marks for practical examination.

2.4.1 PASS REGULATION

For the purposes of determining the overall result, weightage of 100% is applied for six months and one year duration courses and 50% weightage is applied to each examination for two years courses. The minimum pass percent for Trade Practical and Formative assessment is 60% & for all other subjects is 33%.

2.4.2 ASSESSMENT GUIDELINE

Appropriate arrangements should be made to ensure that there will be no artificial barriers to assessment. The nature of special needs should be taken into account while undertaking the assessment. Due consideration should be given while assessing for teamwork, avoidance/reduction of scrap/wastage and disposal of scrap/waste as per procedure, behavioral attitude, sensitivity to the environment and regularity in training. The sensitivity towards OSHE and self-learning attitude are to be considered while assessing competency.

Assessment will be evidence based comprising some of the following:

- Job carried out in labs/workshop
- Record book/ daily diary
- Answer sheet of assessment
- Viva-voce
- Progress chart
- Attendance and punctuality
- Assignment
- Project work
- Computer based multiple choice question examination
- Practical Examination

Evidences and records of internal (Formative) assessments are to be preserved until forthcoming examination for audit and verification by examination body. The following marking pattern to be adopted while for formative assessment:

Performance Level	Evidence
(a) Marks in the range of 60%-75% to be allotted during assessment	

For performance in this grade, the candidate should produce work which demonstrates attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and practices	• Demonstration of good skill in the use of hand tools, machine tools and workshop equipment. • 60-70% accuracy achieved while undertaking different work with those demanded by the component/job. • A fairly good level of neatness and consistency in the finish. • Occasional support in completing the project/job.
(b) Marks in the range of 75%-90% to be allotted during assessment	
For this grade, a candidate should produce work which demonstrates attainment of a reasonable standard of craftsmanship, with little guidance, and regard for safety procedures and practices	• Good skill levels in the use of hand tools, machine tools and workshop equipment. • 70-80% accuracy achieved while undertaking different work with those demanded by the component/job. • A good level of neatness and consistency in the finish. • Little support in completing the project/job.
(c) Marks in the range of more than 90% to be allotted during assessment	
For performance in this grade, the candidate, with minimal or no support in organization and execution and with due regard for safety procedures and practices, has produced work which demonstrates attainment of a high standard of craftsmanship.	• High skill levels in the use of hand tools, machine tools and workshop equipment. • Above 80% accuracy achieved while undertaking different work with those demanded by the component/job. • A high level of neatness and consistency in the finish. • Minimal or no support in completing the project.

3. JOB ROLE

Additive Manufacturing (3D Printing) Technician assists in the designing and programming of products, ranging from prosthetic products to 3D miniatures. Check 3D renders for customers and run 3D printing tests. Process 3D model print request activities and executes 3D prints. Conducts post process 3D prints and inspect 3D Printed models for quality. Additive Manufacturing Technician (3D Printing) can also repair, maintain and clean 3D printers. Assist with repair, upgrade and installation of various software and hardware related to Digital Manufacturing Laboratory facility. Maintain and operate various types of 3D printers and related technologies.

Other job roles may include providing input on ways to streamline the printing process, performing printer finishing tasks like sand blasting or polishing, and collaborating with production personnel to institute new work processes.

Reference NCO Code 2015: Not available

Reference NOS: --

i) G&J/N2307
ii) G&J/N2306
iii) CSC/N9426
iv) CSC/N9427
v) CSC/N9428
vi) CSC/N9429
vii) CSC/N9402

4. GENERAL INFORMATION

Name of the Trade	**ADDITIVE MANUFACTURING (3D PRINTING) TECHNICIAN**
NCO – 2015	Not Available
NOS Covered	G&J/N2307, G&J/N2306, CSC/N9426, CSC/N9427, CSC/N9428, CSC/N9429, CSC/N9402
NSQF Level	Level 3.5
Duration of Craftsmen Training	One Year (1200 Hours + 150 Hours OJT/Group Project)
Entry Qualification	Passed 10th class examination with Science and Mathematics or with vocational subject in same sector or its equivalent.
Minimum Age	14 years as on first day of academic session.
Eligibility for PwD	LD, CP, LC, DW, AA, LV, DEAF, AUTISM, MD
Unit Strength (No. Of Student)	20 (There is no separate provision of supernumerary seats)
Space Norms	120 Sq. m
Power Norms	3 KW (extended battery backup mandatory)
Instructors Qualification for	
(i) Additive Manufacturing (3D Printing) Technician Trade	B.Voc/ Degree in Mechanical/Industrial Engineering/ Mechatronics/Manufacturing/Production/Automobile from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field. **OR** 03 years Diploma in Mechanical/Industrial /Mechatronics/ Manufacturing/Production/Automobile Engineering from AICTE/ recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. **OR** NTC/NAC passed in the trade of "Additive Manufacturing (3D Printing) Technician" with three years' experience in the relevant field. **Essential Qualification:** Relevant Regular / RPL variants of National Craft Instructor Certificate (NCIC) under DGT. **NOTE: - Out of two Instructors required for the unit of 2(1+1), one**

	must have Degree/Diploma and other must have NTC/NAC qualifications. However, both of them must possess NCIC in any of its variants. ***Faculty to be trained for 10 days by the machine manufacturer on the usages of the machines for 3D printing.***
(ii) Workshop Calculation & Science	B.Voc/Degree in Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field. **OR** 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. **OR** NTC/ NAC in any one of the engineering trades with three years' experience. **<u>Essential Qualification:</u>** Regular / RPL variants of National Craft Instructor Certificate (NCIC) in relevant trade **OR** Regular / RPL variants NCIC in RoDA or any of its variants under DGT
(iii) Employability Skill	MBA/ BBA / Any Graduate/ Diploma in any discipline with Two years' experience with **short term ToT Course in** Employability Skills. (Must have studied English/ Communication Skills and Basic Computer at 12th / Diploma level and above) OR **Existing Social Studies Instructors in ITIs with short term ToT Course in** Employability Skills.
(iv) Minimum Age for Instructor	21 Years
List of Tools and Equipment	As per Annexure – I

5. LEARNING OUTCOME

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

5.1 LEARNING OUTCOMES

1. Construct different Geometrical figures using drawing Instruments following safety precautions. (NOS: G&J/N2307)
2. Draw orthographic Projections giving proper dimensioning with title block using appropriate line type and scale. (NOS: G&J/N2307)
3. Draw isometric projection from orthographic views (and vice-versa) and draw oblique projection from orthographic views. (NOS: G&J/N2307)
4. Perform CAD application in 2D interface. (NOS: G&J/N2307)
5. Create and plot assembly and detail views of simple geometrical solid with Dimension, Tolerance & Annotation in 3D Modelling. (NOS: G&J/N2307)
6. Plan and organize the work to make job as per specification applying different types of basic fitting operation and check for dimensional accuracy. *[Basic fitting operation – marking, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm]* (NOS: G&J/N2307)
7. Perform different measurement with desired accuracy to check the components for functionality and conformance to defined standard using different instruments. [*Different measurement: linear, taper, surface roughness, angular, thread; Different instruments: Vernier Calliper, Vernier height gauge, Micrometer, depth gauge, Bevel protector, sine bar, dial test indicator*] (NOS: G&J/N2307)
8. Explain Innovation and Design thinking methodology. (NOS: G&J/N2307)
9. Explain Additive Manufacturing (AM) Technology and emerging trends in Additive Manufacturing. (NOS: G&J/N2307)
10. Make the part applicable for Additive Manufacturing. (NOS: G&J/N2307)
11. Explain different processes of Additive Manufacturing and make simple part of Additive Manufacturing. (NOS: G&J/N2307)
12. Develop a prototype/ end use product. (NOS: G&J/N2306)
13. Apply process algorithm (Slicing Software). (NOS: G&J/N2306)
14. Perform Benchmarking study, concept design, feasibility testing, Industrial design, perceived quality, and Ergonomics. (NOS: CSC/N9426)
15. Suggest ways for optimization. (NOS: CSC/N9426)
16. Identify and explain basic functioning of different electrical equipment, sensors and apply such knowledge in industrial application including basic maintenance work. [Different electrical equipment- multi-meter, transformer, relays, solenoids, motor &

generator; different sensors –proximity & ultrasonic.] Plan & perform simple repair, maintenance of 3D Printing machine and check for functionality. (NOS: CSC/N9427)

17. Carryout basic maintenance of Additive Manufacturing machines. (NOS: G&J/N2306)
18. Create aesthetic models having market appeal. (NOS: G&J/N2306, G&J/N2307-Optional)
19. Apply post processing techniques to finish job. (NOS: CSC/N9428)
20. Scan and process scan data. (NOS: CSC/N9429)
21. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. (NOS: CSC/N9402)

6. ASSESSMENT CRITERIA

LEARNING OUTCOME	ASSESSMENT CRITERIA
1. Construct different Geometrical figures using drawing Instruments following safety precautions. (NOS: G&J/N2307)	Perform assignment using drawing instruments: Draw straight and parallel lines, triangles, polygons, circles, parallelogram, angle bi-sector and line bi-sector.
	Construct regular polygons (up to 8 sides) on equal base.
	Layout a A3 drawing sheet as per Sp -46: 2003 with margin and name plate.
	Fold a sheet of A0 size for filing Cabinets or binding as per SP: 46-2003
	Write block letters & numerals in single & double stroke.
	Write name of the drawing title on heading at centre alignment in double stroke 5:4 block letter.
	Draw a sample title block as used in industry.
	Label a drawing views showing the types of line are used.
	Construct ellipse, parabola & hyperbola.
	Construct involutes, cycloid curves, helix & spiral.
2. Draw orthographic Projections giving proper dimensioning with title block using appropriate line type and scale. (NOS: G&J/N2307)	Generate views in orthographic projection by placing object between horizontal and vertical plane of axes.
	Generate side view of laminar objects in different inclination on VP and HP by auxiliary vertical plane.
	Provide dimension on object as per SP-46:2003
	Draw orthographic projection of points, lines and plain laminar figures.
	Draw orthographic projection of solids viz. prism, cones, pyramids and their frustums in 1st angle and 3rd angle method.
3. Draw isometric projection from orthographic views (and vice-versa) and draw oblique projection from orthographic views. (NOS: G&J/N2307)	Construct an Isometric scale to a given length.
	Draw the isometric projection of regular solids.
	Draw the isometric views for the given solids with hollow and cut sections.
	Draw the orthographic views of hanger, bracket & support from their isometric view.
	Draw isometric view of machine elements (viz. V-block, Angle plate, Sliding block, Journal bearing.
	Draw oblique projection of circular lamina in receding axis at 30° & 45°.
	Draw oblique projection of crank lever and V-block.
4. Perform CAD application	Create 2D geometrical figures using commands from menu bar,

in 2D interface. (NOS: G&J/N2307)	toolbar and by typing in command prompt.
	Create simple object in 2D drawing space.
	Edit 2D objects using modify commands.
	Construct orthographic sectional views of brackets with dimension in different layers.
	Draw isometric view of machine blocks.
	Arrange drawing in multiple viewports within layout space.
5. Create and plot assembly and detail views of simple geometrical solid with Dimension, Tolerance &Annotation in 3D Modeling. (NOS: G&J/N2307)	Create geometrical figures and patterns using sketch entities.
	Create 3D solid figures by Sketching features & applied features.
	Sketch an angle plate and a block – Create / Modify constraints.
	Create geometric dimensioning & tolerance (GD&T) with DimXpert manger.
	Create 3D solid and edit solid.
	Create a new assembly, Insert components into an assembly, Add mates (degree of freedom) and perform components configuration in an assembly.
	Predict aesthetic design, assembly costing, design library & toolbox as per different standards.
	Construct multibody, save as a new part and case study.
	Create a 3D model putting: Driving dimensions, Bill of materials, Driven (Reference) Dimensions and Annotations.
	Prepare drawings & detailing: Named views, standard 3views, auxiliary views, section views and detail views.
	Create a 3D transition figure.
	Create 3D model by annotating Holes and Threads, centerlines, symbols and leaders.
	Create simulation, plot various results, perform design optimization.
	Compute data translation facilitate to export design.
6. Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check for dimensional accuracy. *[Basic fitting operation – marking, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm]* (NOS: G&J/N2307)	Plan & Identify tools, instruments and equipment for marking and make this available for use in a timely manner.
	Select raw material and visually inspect for defects.
	Mark as per specification applying desired mathematical calculation and observing standard procedure.
	Measure all dimensions in accordance with standard specifications and tolerances.
	Identify Hand Tools for different fitting operations and make these available for use in a timely manner.
	Prepare the job for Hacksawing, chiselling, filing, drilling, tapping, grinding.
	Perform basic fitting operations viz., Hacksawing, filing, drilling, tapping and grinding to close tolerance as per specification to make

	the job.
	Observe safety procedure during above operation as per standard norms and company guidelines.
	Check for dimensional accuracy as per standard procedure.
	Avoid waste, ascertain unused materials and components for disposal, store these in an environmentally appropriate manner and prepare for disposal.
7. Perform different measurement with desired accuracy to check the components for functionality and conformance to defined standard using different instruments. [*Different measurement: linear, taper, surface roughness, angular, thread; Different instruments: Vernier Calliper, Vernier height gauge, Micrometer, depth gauge, Bevel protector, sine bar, dial test indicator*] (NOS: G&J/N2307)	Select appropriate measuring instruments such as micrometers, Vernier calipers, dial gauge, bevel protector and height gauge (as per tool list).
	Ascertain the functionality & correctness of the instrument.
	Measure dimension of the components observing standard inspection process & record data to analyse with given drawing/measurement.
8. Explain Innovation and Design thinking methodology. (NOS: G&J/N2307)	Generate multiple ideas based on case study problem statements.
	Gather data from customers with the help of a questionnaire.
	Analyze survey data with tables, charts, graphs, cross tabulations, and more advanced analysis.
	Generating new ideas from different perspective by using Substitute, Combine, Adapt, Magnify/Minify, Reverse, Eliminate, Put to other use (SCAMPER) tool
	Development & refinement in persona.
	Generate multiple ideas based on case study problem statements.
	Gather data from customers with the help of a questionnaire.
	Analyze survey data with tables, charts, graphs, cross tabulations, and more advanced analysis.
9. Explain Additive Manufacturing (AM) Technology and	Explain the underlying principles of Additive Manufacturing (AM).
	Demonstrate various machines used in AM.
	Identify the Extrusion AM technology – Fused Filament &

emerging trends in Additive Manufacturing. (NOS: G&J/N2307)	Continuous Filament fabrication.
	Ensure Digital Light Processing Technology.
	Elaborate the emerging trend in AM.
10. Make the part applicable for Additive Manufacturing. (NOS: G&J/N2307)	Explain the design aspect.
	Identify and demonstrate the software operation for designing a product.
	Assess the design requirement of the part and other dimensional requirement.
	Design a simple part for AM.
	Check and ensure the designed part applicable for AM.
11. Explain different processes of Additive Manufacturing and make simple part of Additive Manufacturing. (NOS: G&J/N2307)	Explain different processes of AM and their features.
	Plan for manufacturing simple part and collect appropriate raw material for the same.
	Manufacture simple item viz., Bracket/ Lever, Clamp, Spur Gear, threaded components etc. by extrusion (FFF Technology) and photo-polymerization (SLA).
	Print composite part by Cloud based slicing software.
	Print plastic part using Photo polymerization (DLP)
	Perform after manufacturing process and measure the component to check different parameters.
12. Develop a prototype/ end use product. (NOS: G&J/N2306)	Examine the product to be developed and estimate the material requirement.
	Develop 3D drawing for the product with application of tolerances and fitments considering 3D printing processes.
	Make a simple assembly/ sub assemble model.
	Carryout after manufacturing process and assemble the components/ sub-assembly.
	Check the functionality of the product/desired output.
13. Apply process algorithm (Slicing Software). (NOS: G&J/N2306)	Explain process algorithm of slicing software and slicing techniques.
	Analyze and apply different process of algorithm for slicing/ supports/ layers/ orientation etc.
	Understand Honeycomb structure.
	Understand Roof & Floor layers in the printers.
	Understand accessing wall layers and internal view display layer.
	Customize fiber routing.
	Understand Turbo print generation and resolution selection.
14. Perform Benchmarking	Introduction to benchmarking.

study, concept design, feasibility testing, Industrial design, perceived quality, and Ergonomics (NOS: CSC/N9426)	Industrial importance of benchmarking.
	Collecting all ideas and creating check list to address problem statement as per case study.
	Selection and testing of final concept design by considering all possibilities like manufacturing, availability, cost, and risk assessment.
	Feasibility assessment Risk Assessment.
15. Suggest ways for optimization. (NOS: CSC/N9426)	Explain concept of optimization/ performance improvement of products.
	Formulate customization and personalization of products.
	Select appropriate of AM and suggest optimization process.
	Evaluate the feedback for optimization.
16. Identify and explain basic functioning of different electrical equipment, sensors and apply such knowledge in industrial application including basic maintenance work. [*Different electrical equipment- multi-meter, transformer, relays, solenoids, motor & generator; different sensors –proximity & ultrasonic.*] Plan & perform simple repair, maintenance of 3D Printing machine and check for functionality. (NOS: CSC/N9402)	Identify differnet electrical equipment viz.multi-meter, transformer, relays, solenoids, motor & generator.
	Identify differnet sensors viz, proximity &ultrasonic.
	Examine functioning of different electrical equipm bent, sensors and their utilization in industrial application.
	Observe safety precautions during examination of electrical equipment and sensors.
	Ascertain and select tools and materials for the repair, maintain and make this available for use in a timely manner.
	Plan work in compliance with standard safety norms.
	Select specific parts to be repaired and ascertain for appropriate material and estimated time.
	Repair/replace and assemble the parts in the machine with the help of blue print.
	Check for functionality of part and ascertain faults of the part/ machine in case of improper function.
	Rectify faults of assembly.
17. Carryout basic maintenance of Additive Manufacturing machines. (NOS: G&J/N2306)	Ascertain and select tools and materials for the maintenance and make this available for use in a timely manner.
	Plan work in compliance with standard safety norms.
	Summarize the machine details and maintenance concept.
	Disassembly and assembly of different components of machine.
	Check for functionality of part and ascertain faults of the part/ machine in case of improper function.
	Rectify faults of assembly.

18. Create aesthetic models having market appeal. (NOS: G&J/N2306 & G&J/N2307- Optional)	Appraise design aspect in additive manufacturing and principles.
	Explain concept of Art design and architecture and use of online model/ resources.
	Design and make aesthetically appealing organic shapes.
	Carryout after manufacturing process.
	Check geometrical parameters and compare with the design.
19. Apply post processing techniques to finish job. (NOS: CSC/N9428)	Explain different post processing techniques for each process.
	Plan, ascertain and select tools and materials for the post processing and make this available for use in a timely manner.
	Finish job by different post processing techniques viz., sanding, cleaning, deburring, curing, painting, polishing etc.
	Measure the dimensions using appropriate measuring instruments.
20. Scan and process scan data. (NOS: CSC/N9429)	Explain scanning techniques and processing of scan data.
	Scan a job at various angles and club/ combine scanned data or images.
	Process the scanned data to develop mesh file (.STL) and create a parametric model (Editable)
	Integrate the model generated by reverse engineering software to the 3D CAD software.
	Export 3D model to various CAD file formats
	Prepare manufacturing drawing and print.
21. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. (NOS: CSC/N9402)	Solve different mathematical problems
	Explain concept of basic science related to the field of study

7. TRADE SYLLABUS

SYLLABUS FOR ADDITIVE MANUFACTURING (3D PRINTING) TECHNICIAN TRADE			
FIRST YEAR			
Duration	**Reference Learning outcome**	**Professional Skills (Trade Practical)**	**Professional Knowledge (Trade Theory)**
Professional Skill 61 Hrs; Professional Knowledge 14 Hrs	LO-1: Construct different Geometrical figures using drawing Instruments following safety precautions.	1. Importance of trade training, List of tools & Machinery used in the trade. 2. Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE) such as use of gloves and goggles. 3. Iso Propyl Alchohol & MSDS Sheet for chemical used in 3D Printing 4. First Aid Method and basic training. 5. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. 6. Hazard identification and avoidance. 7. Safety signs for Danger, Warning, caution & personal safety message. 8. Preventive measures for electrical accidents & steps to be taken in such accidents. 9. Use of Fire extinguishers. 10. Practice and understand precautions to be followed while working in fitting jobs. 11. Safe use of tools and equipment used in the trade by using tweezers for all purposes and handle scrappers.	• Introduction to 3D Printing. All necessary guidance to be provided to the new comers to become familiar with the working of Industrial Training Institute system including stores procedures. • Soft Skills, its importance and Job area after completion of training. • Importance of safety and general precautions observed in the in the industry/shop floor. • Introduction of First aid. Operation of electrical mains and electrical safety. Introduction of PPEs. • Response to emergencies e.g.; power failure, fire, and system failure. **Importance of housekeeping & good shop floor practices.** • Introduction to 5S concept & its application. **Occupational Safety & Health**: • Health, Safety and Environment guidelines, legislations & regulations as applicable. • Basic understanding on Hot work, confined space work and material handling equipment.

		12. Demonstrate the functions of 3D printing and Scanning. 13. Perform Computer operation: i) create new folder, ii) add subfolders, iii) create application files, iv) change appearance of windows, v) search for files, vi) sort files, vii) copy files, viii) create shortcut folder, ix) create shortcut icon in desktop and taskbar x) Move files to and from removable disk/ flash drive. xi) Install a printer from driver software in operating system. 14. Create, save and print a document, worksheet and pdf (portable document format) files.	• Introduction to 3D Printing and Scanning. **Basic computer:** • Introduction to computer, Windows operating system, file management system. • Computer hardware and software specification. • Knowledge of installation of application software.
		Engineering Drawing: 15. Draw perpendicular, inclined (given angle) and parallel lines. Draw triangles with given sides and angles. 16. Construct regular polygons (up to 8 sides) on equal base. 17. Draw inscribed and circumscribed circles of triangle, pentagon and hexagon. 18. Draw a parallelogram with a given length included angle. 19. Draw an angle bi-sector and a line bi-sector. 20. Construction of ellipse, parabola & hyperbola in different methods. 21. Construction of involutes, cycloid curves, helix & spiral.	**Engineering Drawing:** • Nomenclature, description and use of drawing instruments & various equipments used in drawing office. Their care and maintenance. • Recommended scale of engineering drawing as per SP -46 : 2003 • Definition of ellipse, parabola, hyperbola, different methods of their construction. Definition & method of drawing involutes cycloid curves, helix & spiral.

Professional Skill 25Hrs; Professional Knowledge 05Hrs	LO-2: Draw orthographic Projections giving proper dimensioning with title block using appropriate line type and scale.	22. Draw orthographic projection of solids- prisms, cylinders, cones, pyramids. 23. Draw orthographic projection of cut section/ frustums of solids- prism, cylinders, cones, pyramids.	• Units of dimensioning, System of dimensioning, Method of dimensioning & common features. • Methods of obtaining orthographic view. • Position of the object, selection of the views, three views of drawing. Planes and their normal projections. • Orthographic projection. • First angle and third angle projection. • Principal of orthographic projection. Projection of solids like prism, cones, pyramids and their frustums.
Professional Skill 25Hrs; Professional Knowledge 05Hrs	LO-3: Draw isometric projection from orthographic views (and vice-versa) and draw oblique projection from orthographic views.	24. Construct the isometric view of Polygons and circular lamina. 25. Draw isometric view of solid geometrical figures from orthographic views with dimension. 26. Draw isometric views of truncated cone and pyramid. 27. Construct orthographic views from isometric drawing of solid blocks with holes, grooves, notches, dove-tail cut, square cut, round cut, stepped, etc.	• Principle of isometric projection and Isometric drawing. Methods of isometric projection and dimensioning. Isometric scale. Difference between Isometric drawing & Isometric projection. • Principles of making orthographic views from isometric drawing. • Selection of views for construction of orthographic drawings for clear description of the object. •
Professional Skill 35Hrs; Professional Knowledge 10Hrs	LO-4: Perform CAD application in 2D interface.	28. Perform computer application in 2D drawing space using commands from ribbon, menu bar, toolbars and by typing in command prompt. 29. Draw 2D objects using: line, polyline, ray, polygon, circle, rectangle, arc, ellipse	• Introduction to 2D User interface. • Drawing of Line, polyline, ray, polygon, circle, rectangle, arc, ellipse using different options. • Trim, Offset, Fillet, Chamfer, Arc and Circle

		commands. 30. Modify 2D objects using Move, Copy, Array, Insert Block, Make Block, Scale, Rotate, Hatch Commands. 31. Construct orthographic sectional views of bracket with dimension in different layers. 32. Construct isometric view of machine blocks. 33. Create viewports in layout space and place views for model space in different scale.	under modify commands. • Move, Copy, Array, Insert Block, Make Block, Scale, Rotate, Hatch Commands. • Creating templates, Inserting drawings, Layers, Modify Layers. • Format dimension style, creating new dimension style, Modifying styles in dimensioning. Writing text on dimension line and on leader. • Edit text dimension. • Knowledge of shortcut keyboard command. Customization of keyboard command. • Customization of drafting settings, changing orthographic snap to isometric snap. • Procedure to create viewport in layout space in zooming scale.
Professional Skill 90Hrs; Professional Knowledge 30Hrs	LO-5: Create and plot assembly and detail views of simple geometrical solid with Dimension, Tolerance & Annotation in 3D Modeling.	34. Using Sketch entities create: Line, Circle, Polygon, Arc, Slot, Ellipse, Parabola, Spline. Different Rectangles, Helix, Spiral, 2D rapid sketches, reference geometries, sketch patterns, circular patterns, mirror entities, different patterns- Linear, Circular, sketch driven, table driven, equation pattern. 35. Create New Part document. a) Change the dimension values. b) Extrude Base Feature. c) Round the corners of the part. d) Hollow out the part.	**3D Modeling and Design Software:** • Introduction to 3D Modeling and Software. • User interface - Menu Bar – Command manager – Feature manager – Design Tree – settings on the Default options – suggested settings – key board short cuts. • Feature manager Design Tree • Selection of plane • Control of sketches through parameter and property manager. **Featured tools in Command Manager Feature Toolbar.**

		e) Create a circular through hole on the part. f) Create a counter bore g) Create a countersink hole h) Use SWIFT features – Dim Xpert, Feature Xpert, Mate Xpert, Fillet Xpert.	• Extrude Boss/Base • Revolve Boss/Base • Swept Boss/Base • Lofted Boss/Base • Boundary Boss/Base • Extruded cut • Hole Wizard • Revolved Cut • Boundary Cut • Fillet, chamfer, mirror • Linear pattern and circular pattern • Understanding part GD&T with Dim Xpert Manager
		35. Create closed profile for sweeping new plane. 36. Create a hollow rectangular duct. 37. Create 3D solid and edit using: i) Copy & Paste, ii) Filleting, iii) Chamfering, iv) Editing a feature definition. v) Create ribs, mirror pattern, the Hole wizard, Advanced Hole vi) Create part configurations, Part design tables, vii) Inset Design Table, Inset new design table. 38. Draw 3D solid figures by Sketching features & applied features. 39. Sketch an angle plate and a block – Create/ Modify constraints. 40. Make history free part- Defeature. 41. Handle imported geometries using Feature Works – Recognise features to native	• Swept property manager: • Profile and path Options: orientation / twist type and path alignment type Thin feature in swept base • Extrude bosses and cuts, add fillets, and chamfer changing dimensions. • Revolved features using axes, circular patterning changes and Rebuild problems. • Design Automation- Excel, Drive Works Xpress. • Design for Manufacturability –DFMX press • Understanding part costing- Ascertain material costs, machine hour rates, labour costs, miscellaneous costs. Design for costing. • Understanding different modes of part design – Sheet Metal, Weldments for structure, Surface design, Mold Design.

		file formats. 42. Perform part level basic cost estimation.	
		44. Create a 3D transition figure 45. Using loft feature. 46. Using sweep feature. 47. Using library features. 48. Create 3D model by annotating Holes and Threads, 49. Create Centrelines, symbols and leaders, 50. Perform seamless Simulation within CAD- Apply loads & boundary conditions, Material should come from part definition, contacts etc and perform base simulation. 51. Plot various results- Stress, Strain, Deformation, Displacement, Factor of Safety plot, Design Insight plot, probe facility, Iso-clipping, Section clipping. 52. Create automatic reports 53. Understand 2D simplification 54. Learn Data Translation – Built in translation facility to export design to DWG, DXF, Pro E, IPT(Inventor), Mechanical Desktop, Unigraphics, Para Solid, CADKEY, IGES, STEP, PAR (Solid Edge), SAT(ACIS), VDA-FS, VRML, STL, TIFF, JPG, Adobe, Rhino, IDF & HSF. 55. Advanced other file format handling using "3D interconnect" technology. 56. Create simple 3D utility item by assembling different sub-assembly. 57. Modifying & editing the existing solid part model 58. Modifying & editing the	• Difference between sweep and loft. • Exploded views – Configuration manager, Animation controller. • Annotating Holes and Threads, Creating Centerlines, symbols and leaders, Simulation. Introduction to plot & Different ways of plotting.

		existing surface design model. 59. Create general drawing views, projection views, section views, detail views, isometric views of part & assembly on drawing 60. Create assembly coincidence constraint for given parts with all options 61. Create Pattern, mirror for multiple used part in assembly. 62. Modify existing assembly with manipulation tool and modifying existing constraint.	
Professional Skill 35Hrs; Professional Knowledge 10Hrs	LO-6: Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check for dimensional accuracy. *[Basic fitting operation – marking, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm]*	**Manufacturing Technology:** 63. Filing Channel, Parallel. 64. Filing- Flat and square (Rough finish). 65. Filing practice, surface filing, marking of straight and parallel lines with odd leg calipers and steel rule. 66. Marking practice with dividers, odd leg calipers and steel rule (circles, ARCs, parallel lines). 67. Demonstration of Manufacturing Process.	• Files- specifications, description, materials, grades, cuts, file elements, uses. Types of files, care and maintenance of files. • Measuring standards (English, Metric Units), angular measurements. • Different manufacturing processes: • Casting. • Imaging and coating. • Moulding- • Forming. • Machining. • Joining. Finishing. • Advantage & Disadvantage of conventional manufacturing • Additive manufacturing Vs Subtractive manufacturing. • Other. • Types of plastics and its properties (warpage & shrinkage)
		68. Marking according to simple blue prints for locating, position of holes, scribing	• Surface plate and auxiliary marking equipment, 'V' block, angle plates, parallel

		lines on chalked surfaces with marking tools. 69. File steps and finish with smooth file to accuracy of ± 0.25 mm. 70. Mark off and drill through holes. 71. Drill and tap on M.S. flat. 72. Form external threads with dies to standard size.	block, description, types, uses, accuracy, care and maintenance. • Drilling processes: common type (bench type, pillar type, radial type), gang and multiple drilling machine. • Determination of tap drill size. • Dies: British standard, metric and BIS standard, material, parts, types. • Grinding wheel: Abrasive, grade structures, bond, specification and use. Selection of grinding wheels. • Radius/fillet gauge, feeler gauge, hole gauge and their uses, care and maintenance.
Professional Skill 35Hrs; Professional Knowledge 10Hrs	LO-7: Perform different measurement with desired accuracy to check the components for functionality and conformance to defined standard using different instruments. [*Different measurement: linear, taper, surface roughness, angular, thread; Different instruments: Vernier Calliper, Vernier height gauge,*	**Metrology:** 73. Perform linear measurements using Vernier Calliper, Vernier height gauge, and Micrometer. 74. Check surface roughness of a surface plate and components. 75. Measure distance/clearance using dial test indicator.	• Definition of accuracy, precision and error. • Principle of vernier scale and least count. • Measuring methods with Vernier calliper, Micrometers (inside & outside), Telescopic gauge, Height gauge, Depth gauge, Slip gauge. • Major parts, functions and measuring methods of Bevel Protector, Sine bar, Angle gauges, Spirit level, Clinometers, Auto collimator. • Application of Dial Test Indicator/gauge. • Measuring methods of Straightness, Flatness, Squareness, Parallelism, Perpendicularity,

	Micrometer, depth gauge, Bevel protector, sine bar, dial test indicator]		Roundness, Concentricity, Cylindricity, run out, ovality.
		76. Draw the diagram illustrating basic size deviations and tolerances. 77. Draw symbols for machining and surface finishes (grades and micron values). 78. Construct a machine part indicating geometrical tolerance. 79. Prepare a report based on the inspection of any item produced.	• Thread micrometer-method to use and measurement of pitch, major and minor diameters and effective diameter of external thread. • Types of gears. Forms of gear teeth-types and concept. Gear tooth Terminology, measuring methods and measurement illustration of gear tooth vernier. • Limit gauges-classification and applications. • Toleranced dimensioning, geometrical tolerance. Indications of symbols for machining and surface finishes on drawing (grades and micron values) • Production of interchangeable parts, geometrical tolerance. • Familiarization with IS: 919, IS:2709. • Inspection process and report writing.
Professional Skill 35 Hrs; Professional Knowledge 10 Hrs	LO-8: Explain Innovation and Design thinking methodology.	36. Identify five recent innovations. 37. Generate multiple ideas based on case study problem statements. 38. Make a list of tools & methodologies for gathering customer unmet need data. 39. Gather data from customers with the help of a questionnaire.	• Introduction to Innovation and Design Thinking • Necessity of innovation with case studies • Brainstorming session to generate trending deep user needs solutions. • Concept of design thinking exploring & empathies phase to identify customer's unmet needs. or requirements. • Different tools &

		40. Conduct market survey with the help of STEEP & Trend analysis. 41. Analyze survey data with tables, charts, graphs, cross tabulations, and more advanced analysis. 42. Finding the user needs in market by using Social, Physical, Identity, Communication, Emotional (SPICE) framework. 43. Generating new ideas from different perspective by using Substitute, Combine, Adapt, Magnify/Minify, Reverse, Eliminate, Put to other use (SCAMPER) tool. 44. Organize the needs & create a persona. 80. Development & refinement in persona.	Methodologies • used to find customer needs • Defining the strategic priorities of customer demand. • Stakeholder mapping. • Requirement gathering & • management techniques. • Need for market survey. • Various tools & techniques used. • to conduct a market survey. • Introduction to STEEP & TREND analysis. • Current trends & tools used to • conduct market survey. • Concept of Social, Physical, Identity, Communication, Emotional (SPICE) framework. • Concept of Substitute, Combine, Adapt, Magnify/Minify, Reverse, Eliminate, Put to other use (SCAMPER) tool. • Concept of persona development.
Professional Skill 35Hrs; Professional Knowledge 10Hrs	LO-9: Explain Additive Manufacturing Technology and emerging trends in Additive Manufacturing.	81. Demonstrate various machines used in AM (Physical &/or video explaining processes and functions). 82. Produce components by extrusion (FFF) technology and DLP/SLA technology and compare the two processes	• Foundation of Additive Manufacturing (AM); • Definitions of terms used in AM; Different types of machines, Various machines viz., FDM, SLA & SLS (Basic tech Knowledge), AM Manufacturing Industries, Technology Specifications; Emerging trend in AM. • Difference between Additive and Subtractive

			Manufacturing. • Basic material introduction including composites. • Extrusion Additive Manufacturing Technology- Understand Fused Filament Fabrication (FFF) & Continuous Filament Fabrication (CFF) • Digital Light Processing (DLP) • Digital Different AM techniques- • Extrusion Additive Manufacturing • Stereolithography (SLA) • Light Processing (DLP) • Continuous Liquid Interface Production (CLIP) • Material Jetting, Binder Jetting • Material Extrusion • Fused Deposition Modelling (FDM) • Fused Filament Fabrication (FFF) • Contour Crafting • Powder Bed diffusion. • Selective Laser Sintering (SLS) • Direct Metal Laser Sintering (DMLS) • Sheet Lamination • Direct Energy Deposition. • Comparison of different process and material performances in respect of application, strength, finish, precision, etc.
Professional Skill 25Hrs; Professional Knowledge	LO-10: Make a part applicable for Additive Manufacturing.	83. Design simple parts for Additive manufacturing (DFAM).	• Understand product design. • Part design considering requirements for 3 D printing, designing

05Hrs			supports & slicing techniques.
Professional Skill 60Hrs; Professional Knowledge 15Hrs	LO-11: Explain different processes of Additive Manufacturing and make simple part of Additive Manufacturing.	84. Manufacture simple item viz., Bracket/ Lever, Clamp, Spur Gear, threaded components etc. by extrusion additive manufacturing (FFF Technology). 85. Print composite parts with cloud based 3D slicing software. 86. Print plastic part using FDM, Photo polymerisation (DLP) Light Source – Industrial UV LED.	Different technologies &processes of AM: - • Processes under Liquid Based system a. SLA 1.1.1 DLP 1.1.2 Laser based b. Material Jetting 1.2.1 Clay/ Cake/ Chocolate. 1.2.2. Multi jet printing • Processes under Powder Based system 2.1 SLS 2.2 Binder Jetting • Processes under Solid Based System 3.1 FDM/ FFF/ CFF (Extrusion) 3.2 Sheet lamination • Processes under Metal Printing a. DMLS (Direct Metal Laser Sintering) b. PBF (Powder Bed Fusion) c. DED (Direct Energy Deposition) d. EBAM (Electron Beam Additive Manufacturing) e. ADAM (Atomic Diffusion Additive Manufacturing)
Professional Skill 60Hrs; Professional Knowledge 15Hrs	LO-12: Develop a prototype/ end use product. LO-13: Apply process algorithm (3D Slicing Software).	87. Design and make a simple assembly/ sub assemble model. 88. Checkout the various orientation, various settings of the part development using 3D slicing software. 89. Analyse and apply different process of algorithm for	• Application of tolerances and fitments considering 3D printing processes. • Understanding process algorithm of slicing software and slicing techniques. • Understand Honeycomb structure

		slicing/ supports/ layers/ orientation etc.	• Understand Roof & Floor layers in the printers • Understand accessing wall layers • Learn to see the internal view display layer • Understand Turbo print generation, Different resolution selection. • Different Applications like- Functional prototypes, Health care products etc.
Professional Skill 90 Hrs. Professional Knowledge 15 Hrs.	LO-14: Perform Benchmarking study, concept design, feasibility testing, Industrial design, perceived quality, and Ergonomics.	90. Define the problem statement. 91. Collecting all ideas and creating check list to address problem statement as per case study. 92. Selection and testing of final concept design by considering all possibilities like manufacturing, availability, cost, and risk assessment.	• Introduction to benchmarking. Industrial importance of benchmarking. • Tools used for conducting benchmarking. • Concept of gap analysis. • Industrial case studies for benchmarking. Introduction to concept design. • Idea Generation through brainstorming session. • Importance of visualization of concept. • Clearly define the Problem definition to tackle exact issues. • Feasibility assessment • Risk Assessment.
		93. Developing a new product concept considers the function, aesthetics production costs, and usability of products with the help of industrial design study. 94. Make a report of ergonomics study designed product with the aspects of safety,	• Introduction to industrial design and its case study. • Concept of Product based quality. • Importance of Perceived quality. • Variety of strategies used to • improve perceived quality levels. • Concept of Human factors and ergonomic principles.

		comfort, ease of use, productivity/ performance, and aesthetics. 95. Classify the engineering materials (Metals, Polymers, Elastomers, Ceramics, Glasses, and Composites). 96. Selection of material for component or product with the help of Physical properties of materials, Mechanical properties of materials & application of component or product	• Types of ergonomics & its • Importance • Concept of redesign and redevelopment. • • Introduction of Detail design & its documenting procedure, Phases of detail design & its industrial application. • Concept of plans, specifications • and estimates in detail design. • Importance of Material selection • & criteria for material selection. Process of material selection & • testing of material. • Introduction of tooling and its • classification. • Tool management study & its identification documentary
Professional Skill 25Hrs; Professional Knowledge 05Hrs	LO-15: Suggest ways for optimization.	90. Select appropriate of AM and suggest optimization process. (Case studies).	• Concept of optimization/ performance improvement of products. Customization and personalization of products.
Professional Skill 25Hrs; Professional Knowledge 05 Hrs	LO-16: Identify and explain basic functioning of different electrical equipment, sensors and apply such knowledge in industrial application including basic maintenance	91. Measure Current, Voltage and Resistance using Simple Ohm`s Law Circuit And Familiarizing Multi-meter. 92. Simple repair work: Simple assembly of machine parts from blue prints. 93. Rectify possible assembly faults during assembly. 94. Perform the routine maintenance with check list.	• Study of basic Electricals-Voltage –Current etc. • Switches, Fuse And Circuit Breakers • Introduction to Sensors-Proximity Sensors, Types of Proximity Sensor and their Working-Industrial Application • Sensors for Distance and Displacement.

	work. [Different electrical equipment- multi-meter, transformer, relays, solenoids, motor &generator; different sensors – proximity & ultrasonic.] Plan & perform simple repair, maintenance of 3D Printing machine and check for functionality.	95. Monitor machine as per routine checklist. 96. Read pressure gauge, temperature gauge, oil level.	**Maintenance** • -Total Productive Maintenance • -Autonomous maintenance • -Routine maintenance • -Maintenance schedule • -Retrieval of data from machine manuals. • Preventive maintenance- objective and function of Preventive maintenance, section inspection. Visual and detailed, lubrication survey, system of symbol and colour coding. Revision, simple estimation of materials, use of handbooks and reference table. Possible causes for assembly failures and remedies. • Vee belts and their advantages and disadvantages, use of commercial belts, dressing and resin creep and slipping, calculation. **Importance of Technical English terms used in industry** – (in simple definition only) • Technical forms, process charts, activity logs, in required formats of industry, estimation, cycle time, productivity reports, job cards. • Machine productivity concepts – cycle time, down time, cycle time estimation. • Costing - machine hour rate, machining cost, tool cost, cost of down time.
Professional	LO-17: Carryout	97. Disassembly and assembly of	• Understanding of different

Skill 25Hrs; Professional Knowledge 05 Hrs	basic maintenance of Additive Manufacturing machines.	different need based components of machine. 98. Replace various parts of AM machine.	components of machine.
Professional Skill 25Hrs; Professional Knowledge 05 Hrs	LO-18: Create aesthetic models having market appeal.	99. Make aesthetically appealing organic shapes.	• Introduction to design in additive manufacturing and principles. • Basic Concept of Art design and architecture and use of online model/ resources.
Professional Skill 59Hrs; Professional Knowledge 16Hrs	LO-13: Apply process algorithm. (Slicing Software)	100. Analyze and apply different process of algorithm for slicing/supports/ layers/orientation etc.	• Understanding process algorithm of slicing software and slicing techniques. • Understand Honeycomb structure. • Understand Roof & Floor layers in the printers. • Understand accessing wall layers. • Learn to see the internal view display layer. • Understand Turbo print generation, different resolution selection.
Professional Skill 25 Hrs; Professional Knowledge 05 Hrs	LO-19: Apply post processing techniques to finish job.	101. Finish job by different post processing techniques. 102. Quality Checks.	• Different post processing techniques for each process. • viz., sanding, cleaning, deburring, curing, painting, polishing etc.
Professional Skill 45Hrs; Professional Knowledge 15Hrs	LO-20: Scan and process scan data.	103. Scan a job at various angles; club/ combine scanned data or images; process the scanned data to develop mesh file (.STL); create a parametric model (Editable) and prepare manufacturing drawing and print. (The scan data should be processed, automatic alignment, auto-region,	• Scanning techniques and processing of scan data- Reverse engineering. • Method of taking different scan and combining the same; Methods of developing of mesh file; Methods of process of scan data to create a mesh file. • Methods of editing scan data through reverse

		segmenting, making sketches from the mesh data, prepare parametric 3D model from mesh data using Solid Modelling & surfacing techniques.) 104. Export 3D model to various CAD file formats.	engineering.
Workshop Calculation & Science: 38 Hrs.			
Professional Knowledge WCS- 30 Hrs.	LO-21: Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	**WORKSHOP CALCULATION & SCIENCE:** **Unit, Fractions** Classification of unit system Fundamental and Derived units F.P.S, C.G.S, M.K.S and SI units Measurement units and conversion Factors, HCF, LCM and problems Fractions - Addition, substraction, multiplication & division Decimal fractions - Addition, subtraction, multiplication & division Solving problems by using calculator **Square root, Ratio and Proportions, Percentage** Square and square root Simple problems using calculator Applications of Pythagoras theorem and related problems Ratio and proportion Ratio and proportion - Direct and indirect proportions Percentage Percentage - Changing percentage to decimal and fraction **Material Science** Types of plastics and its properties (warpage & shrinkage) **Mass, Weight, Volume and Density** Mass, volume, density, weight and specific gravity **Heat & Temperature and Pressure** Concept of heat and temperature, effects of heat, difference between heat and temperature, boiling point & melting point of different metals and non-metals **Mensuration** Area and perimeter of square, rectangle and parallelogram Area and perimeter of Triangles Area and perimeter of circle, semi-circle, circular ring, sector of circle, hexagon and ellipse Surface area and volume of solids - cube, cuboid, cylinder, sphere and hollow cylinder Finding the lateral surface area, total surface area and capacity in litres of hexagonal, conical and cylindrical shaped vessels **Trigonometry**	

		Measurement of angles Trigonometrical ratios Trigonometrical tables
Project work / Industrial visit: - Project work involving reverse engineering and printing (live industry components simple gear box, biomedical parts, Robotic gripper assembly, Small blower assembly with two parts, simple moulds etc) with QC reports (at least two models) with focus on functional proto types.		

SYLLABUS FOR CORE SKILLS
1. Employability Skills (Common for all CTS trades) (120 Hrs.)

Learning outcomes, assessment criteria, syllabus and Tool List of Core Skills subjects which is common for a group of trades, provided separately in www.bharatskills.gov.in / dgt.gov.in

List of Tools & Equipment			
Additive Manufacturing (3D Printing) Technician (For batch of 20 Candidates)			
S No.	**Name of the Tools and Equipment**	**Specification**	**Quantity**
A. Trainees Tool kit			
1.	Gloves, Goggles		21 (20+1) Set
2.	Measuring Tape	5 M	10 Nos.
B. DRAWING AND CAD LAB TOOLS			
3.	Desktop Computer, latest configure as available at the time of purchase.	CPU: 64 Bit i5/i7 or latest processor, Speed: 3 GHz or Higher. RAM:-16 GB DDR-III or Higher, Wi-Fi Enabled. Network Card: Integrated Gigabit Ethernet, with USB Mouse, USB Keyboard and Monitor (Min. 21 Inch. Or more) Licensed Operating System and Antivirus compatible with trade related software.	20 Nos.
4.	Laptop, latest configure as available at the time of purchase.	CPU: 64 Bit i5/i7 or latest processor, Speed: 3 GHz or Higher. RAM:-16 GB DDR-III or Higher, Wi-Fi Enabled. Network Card: Integrated Gigabit Ethernet, with USB Mouse, USB Keyboard and Monitor (Min. 14 Inch. Licensed Operating System RAM:-16 GB HD/SSD (512)	01 no.
5.	Sever with Rack (May be shared with other trades)	True dedicated sever Intel XEON Processor(Latest), 12 GB or more RAM, Windows Server OS(Latest)	1 No.
6.	Software: MS- office latest version, 3D CAD with latest Licensed version with SWIFT technology, support minimum 24 data translators, Should be directional associative, , should facilitate the Additive Manufacturing technician with latest trends in Engineering costing which should be built in the 3D software,	Re-engineering techniques software should be provided	21 users

	3D software should have facility for scan to 3D operation, 3D software should support single window integration for design & topology optimization, should have facility to prepare "First Article Inspection Reports" for QC process.		
7.	Laser printer latest model	A3 size paper	1 No.
8.	UPS - 5 KVA for printing machine & computer		As required
9.	LCD PROJECTOR with White Board for using LCD projector/Interactive Panel 75" with OPS or more		1 No.
10.	Instructor Table		1 No.
11.	Instructor Chair		2 Nos.
12.	Almirah steel		1 No.
13.	Computer table		20+1Nos.
14.	Computer stools		20+1Nos.
15.	Table for server, printers		1 No. each
16.	External storage device (1TB)		2 Nos.
C. Tools & General Shop Outfit			
17.	Combination Plier Insulated	200 mm	03Nos.
18.	Screw Driver Insulated	4mm X 150 mm, Diamond Head	03Nos.
19.	Screw Driver Insulated	6mm X 150 mm	03Nos.
20.	Hand Vice	50 mm jaw	2 Nos.
21.	Table Vice	100 mm jaw	2 Nos.
22.	Hacksaw frame (with blade)	Adjustable 300 mm Fixed 150 mm	2 Nos. Each
23.	File flat	200 mm 2nd cut with handle	3Nos.
24.	File half round	200 mm 2nd cut with handle	3Nos.
25.	File round	200 mm 2nd cut with handle	3Nos.
26.	Pliers long nose insulated	150 mm	3Nos.
27.	Pliers flat nose insulated	200 mm	4 Nos.
28.	Pliers, round nose insulated	100 mm	4 Nos.
D. MEASURING INSTRUMENT			
29.	Digital venire caliper. (Universal type)	0 - 150 mm, LC 0.05 mm	1 no.
30.	Screw thread micrometer with interchangeable. Pitch anvils for checking metric threads 60.	0 - 25 mm LC 0.01 mm	1 no.
F. General Machinery			
31.	3D Printer- with Direct Light Processing technology (DLP) for liquid based printing	Build Volume – 100mm x 50mm x 150 mm or better with dynamic Z resolution- 0.0001 inches -0.003 inches	01 Nos.

		Software – Prefactory & Magics Light Source – Industrial UV LED.	
32.	Scanner for Reverse Engineering-	Optical scanner tripod mounted with turn table and necessary accessories, accuracy up to 100 microns.	1 No.
33.	Software for Reverse Engineering- (Integrated with CAD)	The scan data should be processed, automatic alignment, auto-region, segmenting, making sketches from the mesh data, prepare parametric 3D model from mesh data using Solid Modeling & surfacing techniques. The software should integrate directly with single window integration to integrate the model generated by reverse engineering software to the 3D CAD software. Create parametric model from. STL scan files	1No.
G. SHOP FLOOR FURNITURE AND MATERIALS			
34.	Working Bench	2.5 m x 1.20 m x 0.75 m	4 Nos.
35.	Locker		
36.	Wiring Board	3 meters x 1 meter with 0.5 meter projection on the top	1 No.
37.	Metal Rack	100cm x 150cm x 45cm	4 Nos.

Note: -

1. *All the tools and equipment are to be procured as per BIS specification, consumables for yearly requirement*
2. Internet facility is desired to be provided in the class room.

ANNEXURE-II

The DGT sincerely acknowledges contributions of the Industries, State Directorates, Trade Experts, Domain Experts, trainers of ITIs, NSTIs, faculties from universities and all others who contributed in revising the curriculum.

Special acknowledgement is extended by DGT to the following expert members who had contributed immensely in this curriculum.

Trade Committee Meeting for trade of "Additive Manufacturing (3D Printing) Technician" under CTS at TATA Technologies, Pune on 14.03.2024			
S. No.	**Name & Designation Sh./Mr./Ms**	**Organization**	**Remarks**
1.	G C Saha	CSTARI, Kolkata	Chairman
2.	Mandar Bhale	TATA Technologies Ltd.	Member
3.	Ronny Gunjal	3D Systems, Goa	Member
4.	Prashant Handigund	TATA Technologies Ltd.	Member cum Coordinator
5.	Daniel D'Souza	TIF Labs	Member
6.	Mangesh Sule	Magnacamz Technologies Pvt. Ltd.	Member
7.	Nitin Singh	Suresh Indu Laser's Pvt. Ltd.	Member
8.	Paresh G. Kenkare	Govt. ITI Aundh, Pune	Member
9.	Dr. Ishtiaq Khan	TATA Technologies Ltd., Pune	Member
10.	Swapnil Kumari	Simusoft Technologies, Pune	Member
11.	Yogesh M. Torpe	Govt. ITI Aundh, Pune	Member
12.	Sunil S Chore	Simusoft Technologies, Pune	Member
13.	C. R. Kanimozhi	Govt. ITI, Madurai	Member
14.	Srinivasan G.	Govt. ITI, Ulundurpet	Member
15.	N Prem Kumar	Govt. ITI, Tindivanam	Member
16.	Dr. D Vivekanandan	Govt. ITI, Dharmapuri	Member

17.	Kishor D Shisat	Govt. ITI Belapur	Member
18.	Sandeep Nimsalka	TATA Technologies Ltd.	Member
19.	Satish Karade	Govt. ITI Phaltan, Satara	Member
20.	Jahir Khatib	TATA Technologies Ltd.	Member
21.	Anil Dhole	TATA Technologies Ltd.	Member
22.	Budhaditya Biswas	CSTARI, Kolkata	Member
23.	P K Bairagi	CSTARI, Kolkata	Member

ABBREVIATIONS:

CTS	Craftsmen Training Scheme
ATS	Apprenticeship Training Scheme
CITS	Craft Instructor Training Scheme
DGT	Directorate General of Training
MSDE	Ministry of Skill Development and Entrepreneurship
NTC	National Trade Certificate
NAC	National Apprenticeship Certificate
NCIC	National Craft Instructor Certificate
LD	Locomotor Disability
CP	Cerebral Palsy
MD	Multiple Disabilities
LV	Low Vision
HH	Hard of Hearing
ID	Intellectual Disabilities
LC	Leprosy Cured
SLD	Specific Learning Disabilities
DW	Dwarfism
MI	Mental Illness
AA	Acid Attack
PwD	Person with disabilities


कौशलं बलम्