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

COMPETENCY BASED CURRICULUM

ADDITIVE MANUFACTURING TECHNICIAN (3D PRINTING)

(Duration: One Year)
Revised in July 2022

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL –3

SECTOR – CAPITAL GOODS & MANUFACTURING

Directorate General of Training

ADDITIVE MANUFACTURING TECHNICIAN (3D PRINTING)

(Engineering Trade)

(Revised in July 2022)

Version: 2.0

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NSQF LEVEL –3

Developed By

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CONTENTS

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, in3D 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

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	• Demonstration of good skill in the use of hand tools, machine tools and workshop

attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and practices	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 Technician (3D Printing) 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) G&J/N9401
iv) G&J/N9402
v) G&J/N9403
vi) G&J/N9404
vii) G&J/N9405
viii) G&J/N9406

4. GENERAL INFORMATION

Name of the Trade	**ADDITIVE MANUFACTURING TECHNICIAN (3D PRINTING)**
Trade Code	DGT/2009
NCO - 2015	Not Available
NOS Covered	G&J/N2307,G&J/N2306,G&J/N9401,G&J/N9402,G&J/N9403,G&J/N9404, G&J/N9405,G&J/N9406
NSQF Level	Level 3
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 Technician (3D Printing) Trade	B.Voc/ Degree in Mechanical/Industrial Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field. **OR** 03 years Diploma in Mechanical/Industrial 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 Technician (3D Printing)" 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. **Essential Qualification:** 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. Make different fit of components for assembling observing principle of interchangeability and check for functionality. *[Different Fit – Step fit; Different surface finishing operations – Scraping, Lapping and Honing;]* (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. Make a simple fixture for functional requirement. (NOS: G&J/N9401)
15. Suggest ways for optimization. (NOS:G&J/N9402)
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:G&J/N9403)

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. Compare different processes and materials. (NOS:G&J/N2306)
20. Apply post processing techniques to finish job. (NOS:G&J/N9404)
21. Scan and process scan data. (NOS:G&J/N9405)
22. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. (NOS:G&J/N9406)

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 in 2D interface. (NOS:G&J/N2307)	Create 2D geometrical figures using commands from menu bar, 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 optimisation.
	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*	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.

and Grinding etc. Accuracy: ± 0.25mm] (NOS:G&J/N2307)	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. Make different fit of components for assembling observing principle of interchangeability and check for functionality. *[Different Fit – Step fit; Different surface finishing operations – Scraping, Lapping and Honing;]* (NOS:G&J/N2307)	Recognize general concept of Limits, Fits and tolerance necessary for fitting applications and functional application of these parameters.
	Ascertain and select tools and materials for the job and make this available for use in a timely manner.
	Set up workplace/ assembly location with due consideration to operational stipulation
	Plan work in compliance with standard safety norms and collecting desired information.
	Demonstrate possible solutions and agree tasks within the team.
	Make components according to the specification for different fit using a range of practical skills and ensuring interchangeability of

	different parts.
	Assemble components applying a range of skills to ensure proper fit.
	Check functionality of components.
9. Explain Additive Manufacturing (AM) Technology and emerging trends in Additive Manufacturing. (NOS:G&J/N2307)	Explain the underlying principles of Additive Manufacturing (AM).
	Demonstrate various machines used in AM.
	Identify the Extrusion AM technology – Fused Filament & 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.
	Analyse 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. Make a simple fixture for functional requirement. (NOS:G&J/N9401)	Identify and examine the different fixtures used in additive manufacturing.
	Design &analyze fixtures and assess various composite materials used based on the requirements.
	Make and test a simple functional fixture viz., C-Clamp, bracket, robotic grippers etc.
	Understand different composite materials & its applications.
	Understand different plastics for DLP method.
15. Suggest ways for optimization. (NOS:G&J/N9402)	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:G&J/N9401)	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	Ascertain and select tools and materials for the maintenance and make this available for use in a timely manner.

Manufacturing machines. (NOS:G&J/N2306)	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. Compare different processes and materials. (NOS:G&J/N2306)	Explain the different AM processes and their features.
	Compare different process and material performances in respect of application, strength, finish, precision, etc.
	Produce components by extrusion (FFF) technology and SLA technology and compare the two processes.
20. Apply post processing techniques to finish job. (NOS:G&J/N9404)	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.
21. Scan and process scan data. (NOS:G&J/N9405)	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.
22. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of	Solve different mathematical problems
	Explain concept of basic science related to the field of study

study. (NOS:G&J/N9406)	

7. TRADE SYLLABUS

SYLLABUS FOR ADDITIVE MANUFACTURING TECHNICIAN (3D PRINTING) TRADE			
FIRST YEAR			
Duration	**Reference Learning outcome**	**Professional Skills (Trade Practical)**	**Professional Knowledge (Trade Theory)**
Professional Skill 64Hrs; Professional Knowledge 14Hrs	Construct different Geometrical figures using drawing Instruments following safety precautions. (NOS:G&J/N2307)	1. Importance of trade training, List of tools & Machinery used in the trade. (03 hrs) 2. Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE) such as use of gloves and goggles. (03 hrs) 3. First Aid Method and basic training. (03 hrs) 4. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. (03 hrs) 5. Hazard identification and avoidance. (03 hrs) 6. Safety signs for Danger, Warning, caution & personal safety message. (03 hrs) 7. Preventive measures for electrical accidents & steps to be taken in such accidents. (03 hrs) 8. Use of Fire extinguishers.(03 hrs) 9. Practice and understand precautions to be followed while working in fitting jobs. (02 hrs) 10. Safe use of tools and equipment used in the trade by using tweezers for all purposes and handle scrappers. (02 hrs)	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. (06 hrs)

		11. Demonstrate the functions of 3D printing and Scanning. (03 hrs) 12. 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. (10 hrs) 13. Create, save and print a document, worksheet and pdf (portable document format) files. (03 hrs)	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. (04hrs)
		Engineering Drawing: 14. Draw perpendicular, inclined (given angle) and parallel lines. Draw triangles with given sides and angles. (04 hrs) 15. Construct regular polygons (up to 8 sides) on equal base. (04 hrs) 16. Draw inscribed and circumscribed circles of triangle, pentagon and hexagon. (02 hrs) 17. Draw a parallelogram with a given length included angle. (02 hrs) 18. Draw an angle bi-sector and a line bi-sector. (02 hrs)	**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. (04hrs)

		19. Construction of ellipse, parabola & hyperbola in different methods. (02 hrs) 20. Construction of involutes, cycloid curves, helix & spiral. (04 hrs)	
Professional Skill 22Hrs; Professional Knowledge 06Hrs	Draw orthographic Projections giving proper dimensioning with title block using appropriate line type and scale. (NOS:G&J/N2307)	21. Draw orthographic projection of solids- prisms, cylinders, cones, pyramids. (10 hrs) 22. Draw orthographic projection of cut section/ frustums of solids- prism, cylinders, cones, pyramids. (12 hrs)	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. (06 hrs)
Professional Skill 22Hrs; Professional Knowledge 06Hrs	Draw isometric projection from orthographic views (and vice-versa) and draw oblique projection from orthographic views. (NOS:G&J/N2307)	23. Construct the isometric view of Polygons and circular lamina. (05 hrs) 24. Draw isometric view of solid geometrical figures from orthographic views with dimension. (06 hrs) 25. Draw isometric views of truncated cone and pyramid. (06 hrs) 26. Construct orthographic views from isometric drawing of solid blocks with holes, grooves, notches, dove-tail cut, square cut, round cut, stepped, etc. (05 hrs)	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. (06 hrs)
Professional Skill 42Hrs; Professional Knowledge	Perform CAD application in 2D interface. (NOS:G&J/N2307)	27. Perform computer application in 2D drawing space using commands from ribbon, menu bar, toolbars and by typing in command prompt.	Introduction to 2D User interface. Drawing of Line, polyline, ray, polygon, circle, rectangle, arc, ellipse using different options.

10Hrs		(10 hrs) 28. Draw 2D objects using: line, polyline, ray, polygon, circle, rectangle, arc, ellipse commands. (08 hrs) 29. Modify 2D objects using Move, Copy, Array, Insert Block, Make Block, Scale, Rotate, Hatch Commands. (08 hrs) 30. Construct orthographic sectional views of bracket with dimension in different layers. (05 hrs) 31. Construct isometric view of machine blocks. (05 hrs) 32. Create viewports in layout space and place views for model space in different scale. (06 hrs)	Trim, Offset, Fillet, Chamfer, Arc and Circle 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. (10hrs)
Professional Skill 126Hrs; Professional Knowledge 30Hrs	Create and plot assembly and detail views of simple geometrical solid with Dimension, Tolerance &Annotation in 3D Modeling. (NOS:G&J/N2307)	33. 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. (25 hrs) 34. 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. e) Create a circular through hole on 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.** Extrude Boss/Base Revolve Boss/Base Swept Boss/Base Lofted Boss/Base Boundary Boss/Base

		f) Create a counter bore g) Create a countersink hole h) Use SWIFT features – DimXpert, FeatureXpert, MateXpert, FilletXpert. (25 hrs)	Extruded cut Hole Wizard Revolved Cut Boundary Cut Fillet, chamfer, mirror Linear pattern and circular pattern Understanding part GD&T with DimXpertManager (12 hrs)
		35. Create closed profile for sweeping new plane. (04 hrs) 36. Create a hollow rectangular duct. (04 hrs) 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. (10 hrs) 38. Draw 3D solid figures by Sketching features & applied features. (10 hrs) 39. Sketch an angle plate and a block – Create/ Modify constraints. (04 hrs) 40. Make history free part- Defeature. (04 hrs) 41. Handle imported geometries using Feature Works – Recognise features to native file formats. (04 hrs) 42. Perform part level basic cost estimation. (02 hrs)	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, DriveWorksXpress. Design for Manufacturability – DFMXpress 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. (12 hrs)
		43. Create a 3D transition figure	Difference between sweep and

		• Using loft feature. • Using sweep feature. • Using library features. i) Create 3D model by annotating Holes and Threads, ii) Create Centrelines, symbols and leaders, iii) Perform seamless Simulation within CAD- Apply loads & boundary conditions, Material should come from part definition, contacts etc and perform base simulation. iv) Plot various results- Stress, Strain, Deformation, Displacement, Factor of Safety plot, Design Insight plot, probe facility, Iso-clipping, Section clipping. v) Create automatic reports vi) Understand 2D simplification (14 hrs) 44. 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. (08 hrs) 45. Advanced other file format handling using "3D interconnect" technology. (04 hrs) 46. Create simple 3D utility item by assembling different sub-assembly. (08 hrs)	loft. Exploded views – Configuration manager, Animation controller. Annotating Holes and Threads, Creating Centerlines, symbols and leaders, Simulation. Introduction to plot & Different ways of plotting. (06hrs)
Professional	Plan and organize	**Manufacturing Technology:**	Files- specifications, description,

Skill 44Hrs; Professional Knowledge 10Hrs	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)	47. Filing Channel, Parallel. (06 hrs) 48. Filing- Flat and square (Rough finish). (06 hrs) 49. Filing practice, surface filing, marking of straight and parallel lines with odd leg calipers and steel rule. (06hrs) 50. Marking practice with dividers, odd leg calipers and steel rule (circles, ARCs, parallel lines). (04hrs)	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. Additive manufacturing. Other. Types of plastics and its properties (warpage& shrinkage) (05hrs)
		51. Marking according to simple blue prints for locating, position of holes, scribing lines on chalked surfaces with marking tools. (04hrs) 52. File steps and finish with smooth file to accuracy of ± 0.25 mm. (06hrs) 53. Mark off and drill through holes. (04hrs) 54. Drill and tap on M.S. flat. (04hrs) 55. Form external threads with dies to standard size. (04 hrs)	Surface plate and auxiliary marking equipment, 'V' block, angle plates, parallel 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. (05hrs)
Professional Skill 44Hrs; Professional	Perform different measurement with desired accuracy to check	**Metrology:** 56. Perform linear measurements using Vernier Calliper, Vernier height gauge, and	Definition of accuracy, precision and error. Principle of vernier scale and least count.

Knowledge 10Hrs	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)	Micrometer. (04 hrs) 57. Measure a taper hole using balls and depth gauge. (04 hrs) 58. Draw the system with indication of geometrical tolerances of form and position as per standard: Straightness, flatness, circularity, cylindricity, parallelism, perpendicularity, angularity, concentricity, coaxiality, symmetry, radial run-out, axial run-out. (04 hrs) 59. Check surface roughness of a surface plate and components. (04 hrs) 60. Perform Angular Measurement using Bevel protector and Sine bar. (04 hrs) 61. Measure distance/clearance using dial test indicator. (04 hrs)	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, Roundness, Concentricity, Cylindricity, run out, ovality. (05 hrs)
		62. Perform Gear and Screw Thread Measurement. (two wire method and screw pitch gauge). (04 hrs) 63. Draw the diagram illustrating basic size deviations and tolerances. (04 hrs) 64. Draw symbols for machining and surface finishes (grades and micron values). (04 hrs) 65. Construct a machine part indicating geometrical tolerance. (04 hrs) 66. Prepare a report based on the inspection of any item produced. (04 hrs)	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. (05 hrs)
Professional Skill 20Hrs; Professional Knowledge 06Hrs	Make different fit of components for assembling observing principle of interchangeability and check for functionality. *[Different Fit – Step fit; Different surface finishing operations – Scraping, Lapping and Honing;]* (NOS:G&J/N2307)	67. Scrap on flat surfaces, curved surfaces and parallel surfaces and test. (04 hrs) 68. Scrape cylindrical bore. (04 hrs) 69. Locate accurate holes & make accurate hole for stud fit. (02hrs) 70. Lap flat surfaces using lapping plate. (02hrs) 71. Lapping holes and cylindrical surfaces. (04hrs) 72. Perform lapping of gauges (hand lapping only). (04 hrs)	**Interchangeability:** Necessity in Engg, Definition. Types of limit, terminology of limits and fits- basic size, actual size, deviation, high and low limit, zero line, tolerance zone Different standard systems of fits and limits. British standard system, BIS system Simple scraper- circular, flat, half round, triangular and hook scraper and their uses. Blue matching of scraped surfaces (flat and curved bearing surfaces) Lapping: Application of lapping, material for lapping tools, lapping abrasives, charging of lapping tool. Surface finish importance, equipment for testing-terms relation to surface finish. Equipment for testing surfaces quality – dimensional tolerances of surface finish. Honing: Application of honing, material for honing, tools shapes, grades, honing abrasives. Treatments to provide a pleasing finish such as chromium silver plating, nickel plating and galvanizing. (06 hrs)
Professional Skill 42Hrs; Professional Knowledge 10Hrs	Explain Additive Manufacturing Technology and emerging trends in Additive Manufacturing. (NOS:G&J/N2307)	73. Demonstrate various machines used in AM (Physical &/or video explaining processes and functions. (42 hrs)	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 (10 hrs)
Professional Skill 20Hrs; Professional Knowledge 04Hrs	Make a part applicable for Additive Manufacturing. (NOS:G&J/N2307)	74. Design a simple part for AM. (20 hrs)	Understand product design. (04hrs)
Professional Skill 63Hrs; Professional Knowledge 16Hrs	Explain different processes of Additive Manufacturing and make simple part of Additive Manufacturing. (NOS:G&J/N2307)	75. Manufacture simple item viz., Bracket/ Lever, Clamp, Spur Gear, threaded components etc. by extrusion additive manufacturing (FFF Technology). (23 hrs) 76. Print composite parts with cloud based slicing software	Different technologies &processes of AM: - 1. Processes under Liquid Based system a. SLA 1.1.1 DLP 1.1.2 Laser based b. Material Jetting

		like Eiger. (20 hrs) 77. Print plastic part using FDM, Photo polymerisation (DLP) Light Source – Industrial UV LED. (20 hrs)	1.2.1 Clay/ Cake/ Chocolate. 1.2.2. Multi jet printing 2. Processes under Powder Based system 2.1 SLS 2.2 Binder Jetting 3. Processes under Solid Based System 3.1 FDM/ FFF/ CFF (Extrusion) 3.2 Sheet lamination 4. 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) (16 hrs)
Professional Skill 63Hrs; Professional Knowledge 16Hrs	Develop a prototype/ end use product. Apply process algorithm (Slicing Software). (NOS:G&J/N2306)	78. Design and make a simple assembly/ sub assemble model. (20 hrs) 79. Checkout the various orientation, various settings of the part development using slicing software. (10 hrs) 80. Analyse and apply different process of algorithm for slicing/ supports/ layers/ orientation etc. (13 hrs) 81. Design for Additive manufacturing (DFAM). (20 hrs)	Application of tolerances and fitments considering 3D printing processes. 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. Different Applications like- Functional prototypes, Health

			care products etc. Part design considering requirements for 3 D printing, designing supports & slicing techniques. (16hrs)
Professional Skill 20Hrs; Professional Knowledge 04Hrs	Make a simple fixture for functional requirement. (NOS:G&J/N9401)	82. Design, analyse, make and test a simple functional fixture viz., C-Clamp, bracket, robotic grippers etc. (20 hrs)	Difference between Jigs & Fixture. Design and analysis of fixtures and various composite materials used based on the requirements. Different composite materials & its applications viz., Onyx (composite of nylon and chopped carbon fibre) , Carbon Fibre, Kevlar, HSHT Fibreglass, Fiberglass Different plastics for DLP method & the printer viz., plastics materials- ABS Flex White, ABS, PEEK Other materials to support- E-Glass, E-Guide Tint, ABS Tough, EC500, E-Dent 100, E-Guard, E-Partial, E-Guard, EPIC, LS600,E shell @200 & @ 300, E-silicone, HTM 140 V2, PIC 100 series, LS 600 etc. (04hrs)
Professional Skill 20Hrs; Professional Knowledge 04Hrs	Suggest ways for optimization. (NOS:G&J/N9402)	83. Select appropriate of AM and suggest optimization process. (Case studies). (20 hrs)	Concept of optimization/ performance improvement of products. Customization and personalization of products. (04hrs)
Professional Skill 20Hrs; Professional Knowledge 06 Hrs	Identify and explain basic functioning of different electrical equipment, sensors and apply such knowledge in industrial application including basic maintenance	84. Measure Current, Voltage and Resistance using Simple Ohm`s Law Circuit And Familiarizing Multi-meter. (04 hrs) 85. Soldering Techniques (02 hrs) 86. Simple repair work: Simple assembly of machine parts from blue prints. (04 hrs) 87. Rectify possible assembly faults during assembly. (02	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. **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:G&J/N9403)	hrs) 88. Perform the routine maintenance with check list. (02 hrs) 89. Monitor machine as per routine checklist. (02 hrs) 90. Read pressure gauge, temperature gauge, oil level.(04 hrs)	-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. (06 hrs)
Professional Skill 20Hrs; Professional Knowledge 06 Hrs	Carryout basic maintenance of Additive Manufacturing machines. (NOS:G&J/N2306)	91. Disassembly and assembly of different need based components of machine. (20hrs)	Understanding of machine details and maintenance concept. (06 hrs)
Professional Skill 20Hrs; Professional	Create aesthetic models having market appeal. (NOS:G&J/N2306	92. Make aesthetically appealing organic shapes. (20 hrs)	Introduction to design in additive manufacturing and principles. Basic Concept of Art design and

Knowledge 04 Hrs	& G&J/N2307- Optional)		architecture and use of online model/ resources. (04hrs)
Professional Skill 40Hrs; Professional Knowledge 08Hrs	Compare different processes and materials. (NOS:G&J/N2306)	93. Produce components by extrusion (FFF) technology and DLP/SLA technology and compare the two processes. (40 hrs)	Comparison of different process and material performances in respect of application, strength, finish, precision, etc. (08hrs)
Professional Skill 65Hrs; Professional Knowledge 16Hrs	Apply process algorithm. (Slicing Software) (NOS:G&J/N2306)	94. Analyze and apply different process of algorithm for slicing/supports/layers/orientation etc. (65 hrs)	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. (16hrs)
Professional Skill 21 Hrs; Professional Knowledge 06 Hrs	Apply post processing techniques to finish job. (NOS:G&J/N9404)	95. Finish job by different post processing techniques. (16 hrs) 96. Quality Checks. (05 hrs)	Different post processing techniques for each process. viz., sanding, cleaning, deburring, curing, painting, polishing etc. (06 hrs)
Professional Skill 42Hrs; Professional Knowledge 10Hrs	Scan and process scan data. (NOS:G&J/N9405)	97. 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, segmenting, making sketches from the mesh data, prepare parametric 3D model from mesh data using Solid Modelling & surfacing techniques.) (37 hrs) 98. Export 3D model to various	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 engineering. (10 hrs)

		CAD file formats. (05 hrs)	
Workshop Calculation & Science: 38 Hrs.			
Professional Knowledge WCS- 38 Hrs.	Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. (NOS:G&J/N9406)	**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

ANNEXURE-I

List of Tools & Equipment			
Additive Manufacturing Technician (3D Printing) (For batch of 20 Candidates)			
S No.	**Name of the Tools and Equipment**	**Specification**	**Quantity**
A. Trainees Tool kit			
1.	Mini drafter, Tweezers, Gloves, Goggles, Scrapers		21(20+1) Set
2.	Steel Rule Graduated both in Metric and English Unit	300 mm with precision of 1/4th mm	21(20+1) Nos.
3.	Try Square	10 cm blade	21(20+1) Nos.
4.	Caliper inside spring type	15 cm	21(20+1) Nos.
5.	Caliper outside spring type	15 cm	21(20+1) Nos.
6.	Divider spring type	15 m	21(20+1) Nos.
B. DRAWING AND CAD LAB TOOLS			
7.	Draughtsman drawing instrument box containing: compasses with pencil point, point driver, interchangeable, Divider pen point interchangeable, divider spring bow pen, Spring bow lengthening bar, pen drawing liner, screw driver Instrument, tube with lead.		20 Nos.
8.	Set square celluloid	45° (250 X 1.5 mm)	20 Nos.
9.	Set square celluloid	30°-60° (250 X 1.5 mm)	20 Nos.
10.	French-curves	set of 12 celluloid	20 Nos.
11.	Drawing board with stand	700mm x500 mm IS: 1444	20 Nos.
12.	Locker	Standard	2 Nos.
13.	Draughtsman stool		20 Nos.
14.	Desktop Computer, latest configure as available at the time of purchase.	CPU: 32/64 Bit i3/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. 17 Inch. Licensed Operating System and Antivirus compatible with trade related software.	20 Nos.
15.	Laptop, latest configure as available at the time of purchase.	RAM:-16 GB HD/SSD (512)	01 no.

16.	Sever	True dedicated sever	1 No.
17.	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, 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.	Re-engineering techniques software should be provided	21 users
18.	Laser printer latest model	A3 size paper	1 No.
19.	UPS - 5 KVA for printing machine & computer		As required
20.	White Board for using LCD projector(optional)		1 No.
21.	Instructor Table		1 No.
22.	Instructor Chair		2 Nos.
23.	Almirah steel		1 No.
24.	Computer table		20+1Nos.
25.	Computer stools		20+1Nos.
26.	Table for server, printers		1 No. each
27.	LCD projector		1 No.
28.	External storage device (1TB)		2 Nos.
C. Tools & General Shop Outfit			
29.	Combination Plier Insulated	200 mm	03Nos.
30.	Screw Driver Insulated	4mm X 150 mm, Diamond Head	03Nos.
31.	Screw Driver Insulated	6mm X 150 mm	03Nos.
32.	Electrician screw driver thin stem insulated handle	4mm X 100 mm	03Nos.
33.	Heavy Duty Screw Driver insulated	5mm X 200 mm	03Nos.
34.	Electrician Screw Driver thin stem insulated handle	4mm X 250 mm	03Nos.
35.	Punch Centre	9mm X 150 mm	03Nos.
36.	Knife Double Bladed Electrician	100 mm	03Nos.
37.	Neon Tester	500 V	03Nos.
38.	Hammer, cross peen with handle	250 grams	04Nos.
39.	Electrical Symbol and Accessories Charts		04 Nos.

40.	Pipe vice Cast Iron with hardened jaw open type	100 mm	2 Nos.
41.	Hand Vice	50 mm jaw	2 Nos.
42.	Table Vice	100 mm jaw	2 Nos.
43.	Hacksaw frame (with blade)	Adjustable 300 mm Fixed 150 mm	2 Nos. Each
44.	File flat	200 mm 2nd cut with handle	3Nos.
45.	File half round	200 mm 2nd cut with handle	3Nos.
46.	File round	200 mm 2nd cut with handle	3Nos.
47.	Pliers long nose insulated	150 mm	3Nos.
48.	Pliers flat nose insulated	200 mm	4 Nos.
49.	Pliers, round nose insulated	100 mm	4 Nos.
50.	D.E. metric Spanner Double Ended	6 - 32 mm	2 Set
51.	Gauge, wire imperial stainless steel marked in SWG & mm	Wire Gauge - Metric	2 Nos.
52.	Portable Electric Drill Machine	0-12 mm capacity 750W, 240V with chuck and key	1 No.
D. MEASURING INSTRUMENT			
53.	Digital venire caliper. (Universal type)	0 - 150 mm, LC 0.05 mm	1 no.
54.	Screw thread micrometer with interchangeable. Pitch anvils for checking metric threads 60.	0 - 25 mm LC 0.01 mm	1 no.
55.	Depth micrometer	200 mm	1 no.
56.	Digital Micrometer outside.	0 - 100 mm L.C. 0.001 mm.	1 no.
57.	Digital Vernier caliper	0 - 200 mm L.C. 0.01 mm (Optional)	1no.
58.	Pillar Type Drilling machine	Sensitive 0-20 mm cap. with swivel table motorised with chuck & key.	1 no.
59.	Portable CMM		1 no.
E. Tool list for Sensors			
60.	Power Supply	(0-30V DC, 3A)	1 no.
61.	**Sensor Kit : Can be used fromElec,Sec**		1 set
	I. Mounting Plate		
	II. Power Distribution Box	(24V DC, 4A)	
	III. Counter Box	(10-30V DC/0.05A)	
	IV. Indication Box	(24V Dc)	
	V. Material Box		
	VI. Inductive Sensor	(10-30 V DC, PNP, NO, 5mm (Range))	
	VII. Capacitive Sensor	(10-30 V Dc, PNP, NO, 2-8mm(Range))	
	VIII. Magnetic Sensor	(10-60 V DC , PNP, NO, 60mm (Range))	
	IX. Ultrasonic Sensor	(20-30 V DC, PNP, NO, 80-300mm(Range))	
	X. Connecting Wires		

F. General Machinery			
62.	3D Printer- with Continuous Filament Fabrication(CFF)	Build Volume -320mm x 132mm x 154mm with z resolution – 100 microns. Software – Cloud based slicing software like Eiger/ Cura or similar software for printing composite materials.	1 No.
63.	3D Printer- FFF (Fused Filament Fabrication)	200x300x200 PLA support	4 Nos.
64.	3D Printer- with Direct Light Processing technology (DLP)	Build Volume – 100mm x 50mm x 150 mm or better with dynamic Z resolution- 0.0001 inches -0.003 inches Software – Prefactory & Magics Light Source – Industrial UV LED.	1 Nos.
65.	Scanner for Reverse Engineering-	Optical scanner tripod mounted with turn table and necessary accessories, accuracy up to 100 microns.	1 No.
66.	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			
67.	Working Bench	2.5 m x 1.20 m x 0.75 m	4 Nos.
68.	Wiring Board	3 meters x 1 meter with 0.5 meter projection on the top	1 No.
69.	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.

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


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