



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

COMPETENCY BASED CURRICULUM

ADDITIVE MANUFACTURING TECHNICIAN (3D PRINTING)

(Duration: One Year)

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL –4



SECTOR – Production & Manufacturing

ADDITIVE MANUFACTURING TECHNICIAN (3D PRINTING)

(Engineering Trade)



(Designed in 2018)

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL –4

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Developed By

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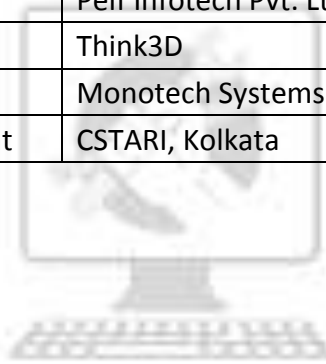
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List of Expert members contributed/ participated for finalizing the course curriculum of Additive Manufacturing Technician (3D Printing) Trade held on 29.08.2018 at Automotive Research Association of India (ARAI), Pune.			
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1. 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. 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 is as below:

1st Year – 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 National Council of Vocational Training (NCVT). Craftsman Training Scheme (CTS) and Apprenticeship Training Scheme (ATS) are two pioneer Programmes of NCVT 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 (Workshop calculation & science, Engineering Drawing and 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 NCVT 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 CAREER PROGRESSION PATHWAYS

- 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.

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)	1120
2.	Professional Knowledge (Trade Theory)	240
3.	Employability Skills	110
4.	Workshop Calculation science	80
5.	Library & Extracurricular Activities	50
6.	Project Work	280
7.	Revision & Examination	200
	Total	2080

2.4 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude during the period of course and at the end of the training programme as notified by the Govt. of India from time to time. The employability skills will be tested in first year only.

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

b) The final assessment will be in the form of summative assessment method. The All India Trade Test for awarding NTC will be conducted by NCVT as per the guideline of Govt of India. The pattern and marking structure is being notified by Govt. of India 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.

c) Outside industrial agencies should be involved to access the project work.

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 Practical is 60% & minimum pass percent for Theory subjects 40%.

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.

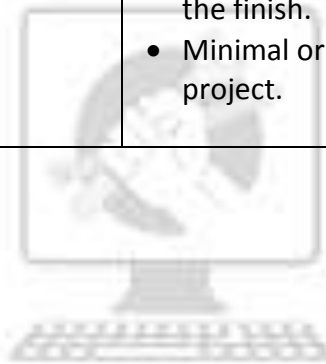
Assessment will be evidence based comprising the following:

- Job carried out in labs/workshop
- Record book/ daily diary
- Answer sheet of assessment
- Viva-voce
- Progress chart
- Attendance and punctuality
- Assignment
- Project work

Evidences of internal assessments are to be preserved until forthcoming examination for audit and verification by examination body. The following marking pattern to be adopted while assessing:

Performance Level	Evidence
(a) Weightage 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	<ul style="list-style-type: none"> • Demonstration of good skill in the use of hand tools, machine tools and workshop equipment. • Below 70% tolerance dimension 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) Weightage 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	<ul style="list-style-type: none"> • Good skill levels in the use of hand tools, machine tools and workshop equipment. • 70-80% tolerance dimension achieved while undertaking different work with those

<p>regard for safety procedures and practices</p>	<p>demande by the component/job.</p> <ul style="list-style-type: none"> • A good level of neatness and consistency in the finish. • Little support in completing the project/job.
<p>(c) Weightage in the range of more than 90% to be allotted during assessment</p>	
<p>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.</p>	<ul style="list-style-type: none"> • High skill levels in the use of hand tools, machine tools and workshop equipment. • Above 80% tolerance dimension 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.



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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.



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4. GENERAL INFORMATION

Name of the Trade	Additive Manufacturing Technician (3D Printing)
NCO - 2015	Not Available
NSQF Level	Level 4
Duration of Craftsmen Training	1 Year
Entry Qualification	Passed 10 th class examination under 10+2 System of education with Science and Mathematics or its equivalent.
Unit Strength (No. Of Student)	16 (Max. supernumeraries seats: 5)
Space Norms	120 Sq. m
Power Norms	3 KW (extended battery backup mandatory)
Instructors Qualification for	
(i) Additive Manufacturing Technician (3D Printing) Trade	<p>Degree in Mechanical/ Industrial Engineering from recognized Engineering College/ university with one year experience in the relevant field.</p> <p style="text-align: center;">OR</p> <p>Diploma in Mechanical/ Industrial Engineering from recognized board of technical education with two years experience in the relevant field.</p> <p style="text-align: center;">OR</p> <p>NTC/ NAC passed in the Trade of "Additive Manufacturing Technician (3D Printing)" With 3 years post qualification experience in the relevant field and one year Craftsman instructor training under CITS.</p> <p><i>Out of two Instructors required for the unit of 2 (1+1), one must have Degree/Diploma and other must have NTC/NAC qualifications.</i></p> <p><i>Note: Faculty to be trained for 10 days by the machine manufacturer on the usages of the machines for 3D printing.</i></p>
(ii) Workshop Calculation & Science	<p>Degree in Engineering with one year experience.</p> <p style="text-align: center;">OR</p> <p>Diploma in Engineering with two years' experience.</p> <p>Desirable: Craft Instructor Certificate in RoD&A course under NCVT.</p>
(iii) Engineering Drawing	Degree in Engineering with one year experience.



	<p style="text-align: center;">OR</p> <p>Diploma in Engineering with two years' experience.</p> <p style="text-align: center;">OR</p> <p>NTC / NAC in the Draughtsman (Mechanical / Civil) with three years' experience.</p> <p>Desirable:</p> <p>Craft Instructor Certificate in RoD& A course under NCVT.</p>				
(iv) Employability Skill	<p>MBA OR BBA with two years' experience OR Graduate in Sociology/ Social Welfare/ Economics with Two years' experience OR Graduate/ Diploma with Two years' experience and trained in Employability Skills from DGET institutes.</p> <p style="text-align: center;">AND</p> <p>Must have studied English/ Communication Skills and Basic Computer at 12th/ Diploma level and above.</p> <p style="text-align: center;">OR</p> <p>Existing Social Studies Instructors duly trained in Employability Skills from DGT institutes</p>				
List of Tools and Equipment	As per Annexure – I				
Distribution of training on Hourly basis: (Indicative only)					
Total Hrs /week	Trade Practical	Trade Theory	Workshop Calc. & Science	Employability Skills	Extra-Curricular Activity
40 Hours	28 Hours	6 Hours	2 Hours	2 Hours	2 Hours

5. NSQF LEVEL COMPLIANCE

NSQF level for **Additive Manufacturing Technician (3D Printing)** Trade under CTS: **Level 4**

As per notification issued by Govt. of India dated- 27.12.2013 on National Skill Qualification Framework total 10 (Ten) Levels are defined.

Each level of the NSQF is associated with a set of descriptors made up of five outcome statements, which describe in general terms, the minimum knowledge, skills and attributes that a learner needs to acquire in order to be certified for that level.

Each level of the NSQF is described by a statement of learning outcomes in five domains, known as level descriptors. These five domains are:

- a. Process
- b. Professional Knowledge
- c. Professional Skill
- d. Core Skill
- e. Responsibility

The broad learning outcome of **Additive Manufacturing Technician (3D Printing)** trade under CTS mostly matches with the Level descriptor at Level - 4.

The NSQF level –4 descriptor is given below:

Level	Process Required	Professional Knowledge	Professional Skill	Core Skill	Responsibility
Level 4	Work in familiar, predictable, routine, situation of clear choice	Factual knowledge of field of knowledge or study	Recall and demonstrate practical skill, routine and repetitive in narrow range of application, using appropriate rule and tool, using quality concepts	Language to communicate written or oral, with required clarity, skill to basic Arithmetic and algebraic principles, basic understanding of social political and natural environment	Responsibility for own work and learning.

6. LEARNING/ ASSESSABLE OUTCOME

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

6.1 GENERIC LEARNING OUTCOME

1. Apply safe working practices
2. Comply with environment regulation and housekeeping.
3. Interpret & use company and technical communication.
4. Demonstrate basic mathematical concept and principles to perform practical operations.
5. Understand and explain basic science in the field of study including simple machine.
6. Read and apply engineering drawing for different application in the field of work.
7. Understand and apply the concept in productivity, quality tools, and labour welfare legislation in day to day work to improve productivity & quality.
8. Explain energy conservation, global warming and pollution and contribute in day to day work by optimally using available resources.
9. Explain personal finance, entrepreneurship and manage/organize related task in day to day work for personal & societal growth.
10. Utilize basic computer applications and internet to take benefit of IT developments in the industry.

6.2 SPECIFIC LEARNING OUTCOME

11. Construct different Geometrical figures using drawing Instruments.
12. Draw orthographic Projections giving proper dimensioning with title block using appropriate line type and scale.
13. Draw isometric projection from orthographic views (and vice-versa) and draw oblique projection from orthographic views.
14. Perform CAD application in 2D interface.
15. Create and plot assembly and detail views of simple geometrical solid with Dimension, Tolerance & Annotation in 3D Modeling.

16. 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: $\pm 0.25\text{mm}$*]
17. 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 Caliper, Vernier height gauge, Micrometer, depth gauge, Bevel protector, sine bar, dial test indicator*]
18. 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;*]
19. Explain Additive Manufacturing (AM) Technology and emerging trends in Additive Manufacturing.
20. Make the part applicable for Additive Manufacturing.
21. Explain different processes of Additive Manufacturing and make simple part of Additive Manufacturing.
22. Develop a prototype/ end use product.
23. Apply process algorithm (Slicing Software).
24. Make a simple fixture for functional requirement.
25. Suggest ways for optimization.
26. 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.
27. Carryout basic maintenance of Additive Manufacturing machines.
28. Create aesthetic models having market appeal.
29. Compare different processes and materials.
30. Apply post processing techniques to finish job.
31. Scan and process scan data.

7. LEARNING OUTCOME WITH ASSESSMENT CRITERIA

GENERIC LEARNING OUTCOME	
LEARNING OUTCOME	ASSESSMENT CRITERIA
1. Apply safe working practices	1.1 Follow and maintain procedures to achieve a safe working environment in line with occupational health and safety regulations and requirements and according to site policy.
	1.2 Recognize and report all unsafe situations according to site policy.
	1.3 Identify and take necessary precautions on fire and safety hazards and report according to site policy and procedures.
	1.4 Identify, handle and store / dispose of dangerous goods and substances according to site policy and procedures following safety regulations and requirements.
	1.5 Identify and observe site policies and procedures in regard to illness or accident.
	1.6 Identify safety alarms accurately.
	1.7 Report supervisor/ Competent of authority in the event of accident or sickness of any staff and record accident details correctly according to site accident/injury procedures.
	1.8 Identify and observe site evacuation procedures according to site policy.
	1.9 Identify Personal Productive Equipment (PPE) and use the same as per related working environment.
	1.10 Identify basic first aid and use them under different circumstances.
	1.11 Identify different fire extinguisher and use the same as per requirement.
2. Comply environment regulation and housekeeping	2.1 Identify environmental pollution & contribute to the avoidance of instances of environmental pollution.
	2.2 Deploy environmental protection legislation & regulations
	2.3 Take opportunities to use energy and materials in an environmentally friendly manner
	2.4 Avoid waste and dispose waste as per procedure
	2.5 Recognize different components of 5S and apply the same in the working environment.
3. Interpret & use company and technical communication	3.1 Obtain sources of information and recognize information.
	3.2 Use and draw up technical drawings and documents.
	3.3 Use documents and technical regulations and occupationally related provisions.
	3.4 Conduct appropriate and target oriented discussions with



	higher authority and within the team.
	3.5 Present facts and circumstances, possible solutions & use English special terminology.
	3.6 Resolve disputes within the team
	3.7 Conduct written communication.
4. Demonstrate basic mathematical concept and principles to perform practical operations.	4.1 Examination to test basic skills on arithmetic, algebra, trigonometry and statistics.
	4.2 Applications will be assessed during execution of assessable outcome and will also be tested during theory and practical examination.
5. Understand and explain basic science in the field of study including simple machine.	5.1 Examination to test basic skills on science in the field of study including friction, heat, temperature and simple machine.
	5.2 Applications will be assessed during execution of assessable outcome and will also be tested during theory and practical examination.
6. Read and apply engineering drawing for different application in the field of work.	6.1 Examination to test basic skills on engineering drawing.
	6.2 Applications will be assessed during execution of assessable outcome and will also be tested during theory and practical examination.
7. Understand and apply the concept in productivity, quality tools, and labour welfare legislation in day to day work to improve productivity & quality.	7.1 Examination to test the concept in productivity, quality tools and labour welfare legislation.
	7.2 Applications will be assessed during execution of assessable outcome.
8. Explain energy conservation, global warming and pollution and contribute in day to day work by optimally using available resources.	8.1 Examination to test knowledge on energy conservation, global warming and pollution.
	8.2 Their applications will be assessed during execution of assessable outcome.
9. Explain personnel finance, entrepreneurship and manage/organize related task in day to day work for personal & societal growth.	9.1 Examination to test knowledge on personnel finance, entrepreneurship.
	9.2 Their applications will be assessed during execution of assessable outcome.

10. Utilize basic computer applications and internet to take benefit of IT developments in the industry.	10.1 Examination to test knowledge on basic computer working, basic operating system and uses internet services.
	10.2 Their applications will be assessed during execution of assessable outcome.



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SPECIFIC LEARNING OUTCOME	
LEARNING OUTCOME	ASSESSMENT CRITERIA
11. Construct different Geometrical figures using drawing Instruments.	11.1 Perform assignment using drawing instruments: Draw straight and parallel lines, triangles, polygons, circles, parallelogram, angle bi-sector and line bi-sector.
	11.2 Construct regular polygons (up to 8 sides) on equal base.
	11.3 Layout a A3 drawing sheet as per Sp -46: 2003 with margin and name plate.
	11.4 Fold a sheet of A0 size for filing Cabinets or binding as per SP: 46-2003
	11.5 Write block letters & numerals in single & double stroke.
	11.6 Write name of the drawing title on heading at centre alignment in double stroke 5:4 block letter.
	11.7 Draw a sample title block as used in industry.
	11.8 Label a drawing views showing the types of line are used.
	11.9 Construct ellipse, parabola & hyperbola.
	11.10 Construct involutes, cycloid curves, helix & spiral.
12. Draw orthographic Projections giving proper dimensioning with title block using appropriate line type and scale.	12.1 Generate views in orthographic projection by placing object between horizontal and vertical plane of axes.
	12.2 Generate side view of laminar objects in different inclination on VP and HP by auxiliary vertical plane.
	12.3 Provide dimension on object as per SP-46:2003
	12.4 Draw orthographic projection of points, lines and plain laminar figures.
	12.5 Draw orthographic projection of solids viz. prism, cones, pyramids and their frustums in 1 st angle and 3 rd angle method.
13. Draw isometric projection from orthographic views (and vice-versa) and draw oblique projection from orthographic views.	13.1 Construct an Isometric scale to a given length.
	13.2 Draw the isometric projection of regular solids.
	13.3 Draw the isometric views for the given solids with hollow and cut sections.
	13.4 Draw the orthographic views of hanger, bracket & support from their isometric view.
	13.5 Draw isometric view of machine elements (viz. V-

	block, Angle plate, Sliding block, Journal bearing.
	13. 6 Draw oblique projection of circular lamina in receding axis at 30° & 45°.
	13. 7 Draw oblique projection of crank lever and V-block.
14. Perform CAD application in 2D interface.	14. 1 Create 2D geometrical figures using commands from menu bar, toolbar and by typing in command prompt.
	14. 2 Create simple object in 2D drawing space.
	14. 3 Edit 2D objects using modify commands.
	14. 4 Construct orthographic sectional views of brackets with dimension in different layers.
	14. 5 Draw isometric view of machine blocks.
	14. 6 Arrange drawing in multiple viewports within layout space.
15. Create and plot assembly and detail views of simple geometrical solid with Dimension, Tolerance & Annotation in 3D Modeling.	15. 1 Create geometrical figures and patterns using sketch entities.
	15. 2 Create 3D solid figures by Sketching features & applied features.
	15. 3 Sketch an angle plate and a block – Create / Modify constraints.
	15. 4 Create geometric dimensioning & tolerance (GD&T) with DimXpert manger.
	15. 5 Create 3D solid and edit solid.
	15. 6 Create a new assembly, Insert components into an assembly, Add mates (degree of freedom) and perform components configuration in an assembly.
	15. 7 Predict aesthetic design, assembly costing, design library & toolbox as per different standards.
	15. 8 Construct multibody, save as a new part and case study.
	15. 9 Create a 3D model putting: Driving dimensions, Bill of materials, Driven (Reference) Dimensions and Annotations.
	15. 10 Prepare drawings & detailing: Named views, standard 3views, auxiliary views, section views and detail views.
	15. 11 Create a 3D transition figure.
	15. 12 Create 3D model by annotating Holes and Threads, centerlines, symbols and leaders.
	15. 13 Create simulation, plot various results, perform

	design optimisation.
	15. 14 Compute data translation facilitate to export design.
16. Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check for dimensional accuracy. <i>[Basic fitting operation – marking, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm]</i>	<p>16. 1. Plan & Identify tools, instruments and equipment for marking and make this available for use in a timely manner.</p> <p>16. 2. Select raw material and visual inspect for defects.</p> <p>16. 3. Mark as per specification applying desired mathematical calculation and observing standard procedure.</p> <p>16. 4. Measure all dimensions in accordance with standard specifications and tolerances.</p> <p>16. 5. Identify Hand Tools for different fitting operations and make these available for use in a timely manner.</p> <p>16. 6. Prepare the job for Hacksawing, chiselling, filing, drilling, tapping, grinding.</p> <p>16. 7. Perform basic fitting operations viz., Hacksawing, filing, drilling, tapping and grinding to close tolerance as per specification to make the job.</p> <p>16. 8. Observe safety procedure during above operation as per standard norms and company guidelines.</p> <p>16. 9. Check for dimensional accuracy as per standard procedure.</p> <p>16. 10. Avoid waste, ascertain unused materials and components for disposal, store these in an environmentally appropriate manner and prepare for disposal.</p>
17. Perform different measurement with desired accuracy to check the components for functionality and conformance to defined standard using different instruments. <i>[Different measurement: linear, taper, surface roughness, angular, thread; Different instruments: Vernier Caliper, Vernier height gauge, Micrometer, depth gauge, Bevel protector, sine bar, dial test indicator]</i>	<p>17. 1. Select appropriate measuring instruments such as micrometers, vernier calipers, dial gauge, bevel protector and height gauge (as per tool list).</p> <p>17. 2. Ascertain the functionality & correctness of the instrument.</p> <p>17. 3. Measure dimension of the components observing standard inspection process & record data to analyse with given drawing/measurement.</p>
18. Make different fit of components	18. 1. Recognize general concept of Limits, Fits and



<p>for assembling observing principle of interchangeability and check for functionality. [<i>Different Fit – Step fit; Different surface finishing operations – Scraping, Lapping and Honing;</i>]</p>	<p>tolerance necessary for fitting applications and functional application of these parameters.</p>
	<p>18. 2. Ascertain and select tools and materials for the job and make this available for use in a timely manner.</p>
	<p>18. 3. Set up workplace/ assembly location with due consideration to operational stipulation</p>
	<p>18. 4. Plan work in compliance with standard safety norms and collecting desired information.</p>
	<p>18. 5. Demonstrate possible solutions and agree tasks within the team.</p>
	<p>18. 6. Make components according to the specification for different fit using a range of practical skills and ensuring interchangeability of different parts.</p>
	<p>18. 7. Assemble components applying a range of skills to ensure proper fit.</p>
	<p>18. 8. Check functionality of components.</p>
<p>19. Explain Additive Manufacturing (AM) Technology and emerging trends in Additive Manufacturing.</p>	<p>19. 1. Explain the underlying principles of Additive Manufacturing (AM).</p>
	<p>19. 2. Demonstrate various machines used in AM.</p>
	<p>19. 3. Identify the Extrusion AM technology – Fused Filament & Continuous Filament fabrication.</p>
	<p>19. 4. Ensure Digital Light Processing Technology.</p>
	<p>19. 5. Elaborate the emerging trend in AM.</p>
<p>20 Make the part applicable for Additive Manufacturing.</p>	<p>20.1 Explain the design aspect.</p>
	<p>20.2 Identify and demonstrate the software operation for designing a product.</p>
	<p>20.3 Assess the design requirement of the part and other dimensional requirement.</p>
	<p>20.4 Design a simple part for AM.</p>
	<p>20.5 Check and ensure the designed part applicable for AM.</p>
<p>21 Explain different processes of Additive Manufacturing and make simple part of Additive Manufacturing.</p>	<p>21. 1 Explain different processes of AM and their features.</p>
	<p>21. 2 Plan for manufacturing simple part and collect appropriate raw material for the same.</p>
	<p>21. 3 Manufacture simple item viz., Bracket/ Lever, Clamp, Spur Gear, threaded components etc. by extrusion (FFF Technology) and photo-polymerization (SLA).</p>
	<p>21. 4 Print composite part by Cloud based slicing software.</p>



	21. 5 Print plastic part using Photo polymerisation (DLP)
	21. 6 Perform after manufacturing process and measure the component to check different parameters.
22 Develop a prototype/ end use product.	22. 1. Examine the product to be developed and estimate the material requirement.
	22. 2. Develop 3D drawing for the product with application of tolerances and fitments considering 3D printing processes.
	22. 3. Make a simple assembly/ sub assemble model.
	22. 4. Carryout after manufacturing process and assemble the components/ sub-assembly.
	22. 5. Check the functionality of the product/desired output.
23 Apply process algorithm (Slicing Software).	23. 1 Explain process algorithm of slicing software and slicing techniques.
	23. 2 Analyse and apply different process of algorithm for slicing/ supports/ layers/ orientation etc.
	23. 3 Understand Honeycomb structure.
	23. 4 Understand Roof & Floor layers in the printers.
	23. 5 Understand accessing wall layers and internal view display layer.
	23. 6 Customize fiber routing.
	23. 7 Understand Turbo print generation and resolution selection.
24 Make a simple fixture for functional requirement.	24. 1 Identify and examine the different fixtures used in additive manufacturing.
	24. 2 Design & analyze fixtures and assess various composite materials used based on the requirements.
	24. 3 Make and test a simple functional fixture viz., C-Clamp, bracket, robotic grippers etc.
	24. 4 Understand different composite materials & its applications.
	24. 5 Understand different plastics for DLP method.
25 Suggest ways for optimization.	25. 1 Explain concept of optimization/ performance improvement of products.
	25. 2 Formulate customization and personalization of products.



	25. 3 Select appropriate of AM and suggest optimization process.
	25. 4 Evaluate the feedback for optimization.
26. 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.	26. 1 Identify different electrical equipment viz .multi-meter, transformer, relays, solenoids, motor & generator.
	26. 2 Identify different sensors viz, proximity & ultrasonic.
	26. 3 Examine functioning of different electrical equipment, sensors and their utilization in industrial application.
	26. 4 Observe safety precautions during examination of electrical equipment and sensors.
	26. 5 Ascertain and select tools and materials for the repair, maintain and make this available for use in a timely manner.
	26. 6 Plan work in compliance with standard safety norms.
	26. 7 Select specific parts to be repaired and ascertain for appropriate material and estimated time.
	26. 8 Repair/replace and assemble the parts in the machine with the help of blue print.
	26. 9 Check for functionality of part and ascertain faults of the part/ machine in case of improper function.
	26. 10 Rectify faults of assembly.
27. Carryout basic maintenance of Additive Manufacturing machines.	27. 1 Ascertain and select tools and materials for the maintenance and make this available for use in a timely manner.
	27. 2 Plan work in compliance with standard safety norms.
	27. 3 Summarize the machine details and maintenance concept.
	27. 4 Disassembly and assembly of different components of machine.
	27. 5 Check for functionality of part and ascertain faults of the part/ machine in case of improper function.
	27. 6 Rectify faults of assembly.
28. Create aesthetic models having market appeal.	28. 1 Appraise design aspect in additive manufacturing and principles.
	28. 2 Explain concept of Art design and architecture and

	use of online model/ resources.
	28. 3 Design and make aesthetically appealing organic shapes.
	28. 4 Carryout after manufacturing process.
	28. 5 Check geometrical parameters and compare with the design.
29. Compare different processes and materials.	29. 1 Explain the different AM processes and their features.
	29. 2 Compare different process and material performances in respect of application, strength, finish, precision, etc.
	29. 3 Produce components by extrusion (FFF) technology and SLA technology and compare the two processes.
30. Apply post processing techniques to finish job.	30. 1 Explain different post processing techniques for each process.
	30. 2 Plan, ascertain and select tools and materials for the post processing and make this available for use in a timely manner.
	30. 3 Finish job by different post processing techniques viz., sanding, cleaning, deburring, curing, painting, polishing etc.
	30. 4 Measure the dimensions using appropriate measuring instruments.
31. Scan and process scan data.	31. 1. Explain scanning techniques and processing of scan data.
	31. 2. Scan a job at various angles and club/ combine scanned data or images.
	31. 3. Process the scanned data to develop mesh file (.STL) and create a parametric model (Editable)
	31. 4. Integrate the model generated by reverse engineering software to the 3D CAD software.
	31. 5. Export 3D model to various CAD file formats
	31. 6. Prepare manufacturing drawing and print.

SYLLABUS - ADDITIVE MANUFACTURING TECHNICIAN (3D PRINTING)			
FIRST YEAR			
Week No.	Reference Learning outcome	Professional Skills (Trade Practical)	Professional Knowledge (Trade Theory)
1	Apply safe working practices and comply with environment regulation	<ol style="list-style-type: none"> 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. First Aid Method and basic training. 4. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. 5. Hazard identification and avoidance. 6. Safety signs for Danger, Warning, caution & personal safety message. 7. Preventive measures for electrical accidents & steps to be taken in such accidents. 8. Use of Fire extinguishers. 9. Practice and understand precautions to be followed while working in fitting jobs. 10. Safe use of tools and equipment used in the trade by using tweezers for all purposes and handle scrappers. 	<p>All necessary guidance to be provided to the new comers to become familiar with the working of Industrial Training Institute system including stores procedures.</p> <p>Soft Skills, its importance and Job area after completion of training.</p> <p>Importance of safety and general precautions observed in the in the industry/shop floor.</p> <p>Introduction of First aid.</p> <p>Operation of electrical mains and electrical safety.</p> <p>Introduction of PPEs.</p> <p>Response to emergencies e.g.; power failure, fire, and system failure.</p> <p>Importance of housekeeping & good shop floor practices.</p> <p>Introduction to 5S concept & its application.</p> <p>Occupational Safety & Health: Health, Safety and Environment guidelines, legislations & regulations as applicable.</p> <p>Basic understanding on Hot work, confined space work and material handling equipment.</p>



2	Construct different Geometrical figures using drawing Instruments.	<p>11. Demonstrate the functions of 3D printing and Scanning.</p> <p>12. Perform Computer operation:</p> <ul style="list-style-type: none"> 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. <p>13. Create, save and print a document, worksheet and pdf (portable document format) files.</p>	<p>Introduction to 3D Printing and Scanning.</p> <p>Basic computer:</p> <p>Introduction to computer, Windows operating system, file management system.</p> <p>Computer hardware and software specification.</p> <p>Knowledge of installation of application software.</p>
3	-do-	<p>Engineering Drawing:</p> <p>14. Draw perpendicular, inclined (given angle) and parallel lines. Draw triangles with given sides and angles.</p> <p>15. Construct regular polygons (up to 8 sides) on equal base.</p> <p>16. Draw inscribed and circumscribed circles of triangle, pentagon and hexagon.</p> <p>17. Draw a parallelogram with a given length included angle.</p> <p>18. Draw an angle bi-sector and a line bi-sector.</p> <p>19. Construction of ellipse, parabola & hyperbola in different methods.</p> <p>20. Construction of involutes, cycloid curves, helix & spiral.</p>	<p>Engineering Drawing:</p> <p>Nomenclature, description and use of drawing instruments & various equipments used in drawing office. Their care and maintenance.</p> <p>Recommended scale of engineering drawing as per SP -46 : 2003</p> <p>Definition of ellipse, parabola, hyperbola, different methods of their construction. Definition & method of drawing involutes cycloid curves, helix & spiral.</p>

<p>4</p>	<p>Draw orthographic Projections giving proper dimensioning with title block using appropriate line type and scale.</p>	<p>21. Draw orthographic projection of solids- prisms, cylinders, cones, pyramids. 22. Draw orthographic projection of cut section/ frustums of solids- prism, cylinders, cones, pyramids.</p>	<p>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.</p>
<p>5</p>	<p>Draw isometric projection from orthographic views (and vice-versa) and draw oblique projection from orthographic views.</p>	<p>23. Construct the isometric view of Polygons and circular lamina. 24. Draw isometric view of solid geometrical figures from orthographic views with dimension. 25. Draw isometric views of truncated cone and pyramid. 26. Construct orthographic views from isometric drawing of solid blocks with holes, grooves, notches, dove-tail cut, square cut, round cut, stepped, etc.</p>	<p>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.</p>
<p>6-7</p>	<p>Perform CAD application in 2D interface .</p>	<p>27. Perform computer application in 2D drawing space using commands from ribbon, menu bar, toolbars and by typing in command prompt. 28. Draw 2D objects using:line, polyline, ray, polygon, circle, rectangle, arc, ellipse commands. 29. Modify 2D objects using Move, Copy, Array, Insert Block, Make Block, Scale, Rotate, Hatch Commands. 30. Construct orthographic sectional views of bracket with dimension in different layers.</p>	<p>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 under modify commands. Move, Copy, Array, Insert Block, Make Block, Scale, Rotate, Hatch Commands. Creating templates, Inserting</p>

		<p>31. Construct isometric view of machine blocks.</p> <p>32. Create viewports in layout space and place views for model space in different scale.</p>	<p>drawings, Layers, Modify Layers.</p> <p>Format dimension style, creating new dimension style, Modifying styles in dimensioning. Writing text on dimension line and on leader. Edit text dimension.</p> <p>Knowledge of shortcut keyboard command.</p> <p>Customization of keyboard command.</p> <p>Customization of drafting settings, changing orthographic snap to isometric snap.</p> <p>Procedure to create viewport in layout space in zooming scale.</p>
<p>8-9</p>	<p>Create and plot assembly and detail views of simple geometrical solid with Dimension, Tolerance & Annotation in 3D Modeling.</p>	<p>3D Modeling and Design Software:</p> <p>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</p> <p>34. Create New Part document.</p> <ol style="list-style-type: none"> Change the dimension values. Extrude Base Feature. Round the corners of the part. Hollow out the part. Create a circular through hole on the part. Create a counter bore Create a countersink hole Use <u>SWIFT</u> features – DimXpert, FeatureXpert, MateXpert, FilletXpert 	<p>Introduction to 3D Modeling and Software.</p> <p>User interface - Menu Bar – Command manager – Feature manager – Design Tree – settings on the Default options – suggested settings – key board short cuts.</p> <p>Feature manager Design Tree Selection of plane</p> <p>Control of sketches through parameter and property manager.</p> <p>Featured tools in Command Manager Feature Toolbar.</p> <p>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</p>



			<p>pattern</p> <p>Understanding part GD&T with DimXpertManager</p>
10-11	-do-	<p>35. Create closed profile for sweeping new plane.</p> <p>36. Create a hollow rectangular duct.</p> <p>37. Create 3D solid and edit using:</p> <ol style="list-style-type: none"> i) Copy & Paste, ii) Filletting, 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. <p>38. Draw 3D solid figures by Sketching features & applied features.</p> <p>39. Sketch an angle plate and a block – Create/ Modify constraints.</p> <p>40. Make history free part- Defeature.</p> <p>41. Handle imported geometries using FeatureWorks – Recognise features to native file formats.</p> <p>42. Perform part level basic cost estimation.</p>	<p>Swept property manager: Profile and path</p> <p>Options: orientation / twist type and path alignment type</p> <p>Thin feature in swept base</p> <p>Extrude bosses and cuts, add fillets, and chamfer changing dimensions.</p> <p>Revolved features using axes, circular patterning changes and Rebuild problems.</p> <p>Design Automation- Excel, DriveWorksXpress.</p> <p>DesignFor Manufacturability –DFMXpress</p> <p>Understanding part costing- Ascertain material costs, machine hour rates, labour costs, miscellaneous costs.</p> <p>Design for costing.</p> <p>Understanding different modes of part design – Sheet Metal, Weldments for structure, Surface design, Mold Design</p>
12-13	-do-	<p>43. Create a 3D transition figure</p> <ul style="list-style-type: none"> • using loft feature. • using sweep feature. • using library features. <ol style="list-style-type: none"> 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 	<p>Difference between sweep and loft.</p> <p>Exploded views – Configuration manager, Animation controller.</p> <p>Annotating Holes and Threads, Creating Centerlines, symbols and leaders, Simulation.</p> <p>Introduction to plot & Different ways of plotting.</p>




		<p>of Safety plot, Design Insight plot, probe facility, Iso-clipping, Section clipping.</p> <p>v) Create automatic reports</p> <p>vi) Understand 2D simplification</p> <p>43. Learn Data Translation – Built in translation facility to export design to DWG, DXF, ProE, IPT(Inventor), Mechanical Desktop, Unigraphics, ParaSolid, CADKEY, IGES, STEP, .PAR(SolidEdge), SAT(ACIS), VDA-FS, VRML, STL, TIFF, JPG, Adobe, Rhino, IDF & HSF.</p> <p>44. Advanced other file format handling using "3D interconnect" technology</p> <p>45. Create simple 3D utility item by assembling different sub-assembly.</p>	
14	<p>Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check for dimensional accuracy.</p> <p><i>[Basic fitting operation – marking, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm]</i></p>	<p>Manufacturing Technology:</p> <p>46. Filing Channel, Parallel.</p> <p>47. Filing- Flat and square (Rough finish)</p> <p>48. Filing practice, surface filing, marking of straight and parallel lines with odd leg calipers and steel rule.</p> <p>49. Marking practice with dividers, odd leg calipers and steel rule (circles, ARCs, parallel lines).</p>	<p>Files- specifications, description, materials, grades, cuts, file elements, uses. Types of files, care and maintenance of files.</p> <p>Measuring standards (English, Metric Units), angular measurements.</p> <p>Different manufacturing processes:</p> <p>Casting.</p> <p>Imaging and coating.</p> <p>Moulding-</p> <p>Forming.</p> <p>Machining.</p> <p>Joining.</p> <p>Additive manufacturing.</p> <p>Other.</p> <p>Types of plastics and its properties (warpage & shrinkage)</p>
15	-do-	50. Marking according to simple blue prints for locating, position of holes, scribing lines on chalked surfaces with	Surface plate and auxiliary marking equipment, 'V' block, angle plates, parallel block,

		<p>marking tools.</p> <p>51. File steps and finish with smooth file to accuracy of ± 0.25 mm.</p> <p>52. Mark off and drill through holes.</p> <p>53. Drill and tap on M.S. flat.</p> <p>54. Form external threads with dies to standard size.</p>	<p>description, types, uses, accuracy, care and maintenance.</p> <p>Drilling processes: common type (bench type, pillar type, radial type), gang and multiple drilling machine.</p> <p>Determination of tap drill size.</p> <p>Dies: British standard, metric and BIS standard, material, parts, types.</p> <p>Grinding wheel: Abrasive, grade structures, bond, specification and use.</p> <p>Selection of grinding wheels.</p> <p>Radius/fillet gauge, feeler gauge, hole gauge and their uses, care and maintenance.</p>
<p>16</p>	<p>Perform different measurement with desired accuracy to check the components for functionality and conformance to defined standard using different instruments.</p> <p><i>[Different measurement: linear, taper, surface roughness, angular, thread; Different instruments: Vernier Calliper, Vernier height gauge,</i></p>	<p>Metrology:</p> <p>55. Perform linear measurements using Vernier Calliper, Vernier height gauge, and Micrometer.</p> <p>56. Measure a taper hole using balls and depth gauge.</p> <p>57. 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.</p> <p>58. Check surface roughness of a surface plate and components</p> <p>59. Perform Angular Measurement using Bevel protector and Sine bar.</p> <p>60. Measure distance/clearance using dial test indicator.</p>	<p>Definition of accuracy, precision and error.</p> <p>Principle of vernier scale and least count.</p> <p>Measuring methods with Vernier calliper, Micrometers (inside & outside), Telescopic gauge, Height gauge, Depth gauge, Slip gauge.</p> <p>Major parts, functions and measuring methods of Bevel Protector, Sine bar, Angle gauges, Spirit level, Clinometers, Auto collimator.</p> <p>Application of Dial Test Indicator/gauge.</p> <p>Measuring methods of Straightness, Flatness, Squareness, Parallelism, Perpendicularity, Roundness, Concentricity, Cylindricity, run out, ovality.</p>

	<i>Micrometer, depth gauge, Bevel protector, sine bar, dial test indicator]</i>		
17	-do-	<p>61. Perform Gear and Screw Thread Measurement.(two wire method and screw pitch gauge)</p> <p>62. Draw the diagram illustrating basic size deviations and tolerances</p> <p>63. Draw symbols for machining and surface finishes (grades and micron values)</p> <p>64. Construct a machine part indicating geometrical tolerance.</p> <p>65. Prepare a report based on the inspection of any item produced.</p>	<p>Thread micrometer- method to use and measurement of pitch, major and minor diameters and effective diameter of external thread.</p> <p>Types of gears. Forms of gear teeth-types and concept.</p> <p>Gear tooth Terminology, measuring methods and measurement illustration of gear tooth vernier.</p> <p>Limit gauges-classification and applications.</p> <p>Toleranced dimensioning, geometrical tolerance.</p> <p>Indications of symbols for machining and surface finishes on drawing(grades and micron values)</p> <p>Production of interchangeable parts, geometrical tolerance.</p> <p>Familiarization with IS: 919, IS:2709.</p> <p>Inspection process and report writing.</p>
18	<p>Make different fit of components for assembling observing principle of interchangeability and check for functionality.</p> <p><i>[Different Fit – Step fit; Different surface finishing operations –</i></p>	<p>66. Scrap on flat surfaces, curved surfaces and parallel surfaces and test.</p> <p>67. Scrape cylindrical bore.</p> <p>68. Locate accurate holes & make accurate hole for stud fit.</p> <p>69. Lap flat surfaces using lapping plate.</p> <p>70. Lapping holes and cylindrical surfaces.</p> <p>71. Perform lapping of gauges (hand lapping only)</p>	<p>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</p> <p>Different standard systems of fits and limits. British standard system, BIS system</p> <p>Simple scraper- circular, flat, half round, triangular and hook scraper and their uses.</p> <p>Blue matching of scraped surfaces (flat and curved</p>

	<p><i>Scraping, Lapping and Honing;]</i></p>		<p>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.</p>
<p>19-20</p>	<p>Explain Additive Manufacturing Technology and emerging trends in Additive Manufacturing.</p>	<p>72. Demonstrate various machines used in AM (Physical &/or video explaining processes and functions</p>	<p>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)</p>



			<p>Digital Different AM techniques- Extrusion Additive Manufacturing</p> <p>Stereolithography (SLA)</p> <p>Light Processing(DLP)</p> <p>Continuous Liquid Interface Production(CLIP)</p> <p>Material Jetting, Binder Jetting</p> <p>Material Extrusion</p> <p>Fused Deposition Modeling (FDM)</p> <p>Fused Filament Fabrication(FFF)</p> <p>Contour Crafting</p> <p>Powder Bed diffusion.</p> <p>Selective Laser Sintering(SLS)</p> <p>Direct Metal Laser Sintering(DMLS)</p> <p>Sheet Lamination</p> <p>Direct Energy Deposition</p>
21	Make a part applicable for Additive Manufacturing.	73. Design a simple part for AM.	Understand product design.
22-24	Assignment work / Industrial visit: -5 or 6 assignments on simple parts Design and develop 3D model and perform simulation with single window integration (CAD/ CAE/ CFD) in single GUI without any data loss.		
25-26	Revision		
27-29	Explain different processes of Additive Manufacturing	74. Manufacture simple item viz., Bracket/ Lever, Clamp, Spur Gear, threaded components etc. by extrusion additive manufacturing (FFF Technology)	<p>Different technologies & processes of AM: -</p> <ol style="list-style-type: none"> 1. Processes under Liquid Based system <ol style="list-style-type: none"> a. SLA

	<p>and make simple part of Additive Manufacturing.</p>	<p>75. Print composite parts with cloud based slicing software like Eiger. 76. Print plastic part using FDM, Photo polymerisation (DLP) Light Source – Industrial UV LED</p> 	<p>1.1.1 DLP 1.1.2 Laser based b. Material Jetting 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)</p>
<p>30-32</p>	<p>Develop a prototype/ end use product. Apply process algorithm (Slicing Software).</p>	<p>77. Design and make a simple assembly/ sub assemble model. 78. Checkout the various orientation, various settings of the part development using slicing software 79. Analyse and apply different process of algorithm for slicing/ supports/ layers/ orientation etc. 80. Applications of Additive Manufacturing 81. Design For Additive manufacturing (DFAM)</p>	<p>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</p>

			<p>resolution selection.</p> <p>Different Applications like- Functional prototypes, Health care products etc.</p> <p>Part design considering requirements for 3 D printing, designing supports & slicing techniques</p>
33	Make a simple fixture for functional requirement.	<p>82. Design, analyse, make and test a simple functional fixture viz., C-Clamp, bracket, robotic grippers etc</p> 	<p>Difference between Jigs & Fixture.</p> <p>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</p> <p>Different plastics for DLP method & the printer viz., plastics materials- ABS Flex White, ABS, PEEK</p> <p>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</p>
34	Suggest ways for optimization.	83. Select appropriate of AM and suggest optimization process. (Case studies)	<p>Concept of optimization/ performance improvement of products. Customization and personalization of products.</p>

<p>35</p>	<p>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.</p>	<p>84. Measure Current, Voltage and Resistance using Simple Ohm's Law Circuit And Familiarizing Multi-meter.</p> <p>85. Soldering Techniques</p> <p>86. Simple repair work: Simple assembly of machine parts from blue prints.</p> <p>87. Rectify possible assembly faults during assembly.</p> <p>88. Perform the routine maintenance with check list.</p> <p>89. Monitor machine as per routine checklist.</p> <p>90. Read pressure gauge, temperature gauge, oil level.</p> 	<p>Study of basic Electricals- Voltage –Current etc. Switches, Fuse And Circuit Breakers</p> <p>Introduction to Sensors- Proximity Sensors, Types of Proximity Sensor and their Working-Industrial Application</p> <p>Sensors for Distance and Displacement.</p> <p>Maintenance</p> <ul style="list-style-type: none"> -Total Productive Maintenance -Autonomous maintenance -Routine maintenance -Maintenance schedule -Retrieval of data from machine manuals. <p>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.</p> <p>Vee belts and their advantages and disadvantages, Use of commercial belts, dressing and resin creep and slipping, calculation.</p> <p>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</p>
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			cards. Machine productivity concepts – cycle time, down time, cycle time estimation. Costing - machine hour rate, machining cost, tool cost, cost of down time.
36	Carryout basic maintenance of Additive Manufacturing machines.	91. Disassembly and assembly of different need based components of machine.	Understanding of machine details and maintenance concept.
37	Create aesthetic models having market appeal.	92. 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.
38-39	Compare different processes and materials.	93. Produce components by extrusion (FFF) technology and DLP/SLA technology and compare the two processes.	Comparison of different process and material performances in respect of application, strength, finish, precision, etc.
40-42	Apply process algorithm. (Slicing Software)	94. 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.
43	Apply post processing techniques to finish job.	95. Finish job by different post processing techniques. 96. Quality Checks	Different post processing techniques for each process. viz., sanding, cleaning, deburring, curing, painting, polishing etc



44-45	Scan and process scan data.	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 Modeling & surfacing techniques.) 98. Export 3D model to various CAD file formats	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.
46 - 49	Project work / Industrial visit: - a) 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.		
50 - 51	Revision		
52	Examination		

Note: -

1. Some of the sample project works (indicative only) are given at the mid and end of each year.
2. Instructor may design their own projects and also inputs from local industry may be taken for designing such new projects.
3. The project should broadly cover maximum skills in the particular trade and must involve some problem solving skill. Emphasis should be on Teamwork: Knowing the power of synergy/ collaboration, work to be assigned in a group (Group of at least 4 trainees). The group should demonstrate Planning, Execution, Contribution and Application of Learning. They need to submit a Project report after completion.
4. If the instructor feels that for execution of specific project more time is required then he may plan accordingly in appropriate time during the execution of normal trade practical.

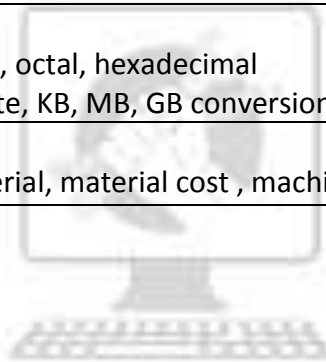
9. SYLLABUS - CORE SKILLS

9.1 WORKSHOP CALCULATION AND SCIENCE:

First Year	
S No.	Workshop Calculation and Science
1.	Units: Physical quantities and types, Fundamental and Derived units, Systems of units- FPS, CGS, MKS/SI unit, unit of length, Mass and time, Conversion of units.
2.	Fractions: Decimal fraction, Addition, Subtraction, Multiplication and Division of Fractions and Decimals, conversion of Fraction to Decimal and vice versa. Simple problems.
3.	Ratio and Proportion: Ratio, Proportion – types- direct and indirect. Simple calculation on related problems.
4.	Percentage: Conversion of percentage to decimal and fraction and vice-versa. Loss and Profit. Simple calculations.
5.	<p>Material Science :Properties -Physical & Mechanical, Types –Ferrous & Non-Ferrous, difference between Ferrous and Non-Ferrous metals, difference between Iron and Steel, Alloy steel, carbon steel, stainless steel.</p> <p>Metals, non-metals, semiconductors, ceramics and polymers.</p> <p>Definitions of strength, toughness, ductility, hardness, malleability, corrosion resistance, wear resistance, thermal and electrical conductivity.</p> <p>Stress, strain, ultimate strength, factor of safety.</p> <p>Non-Ferrous metals, Non-Ferrous Alloys.</p> <p>Introduction of plastic, Group of plastic, Properties and used of Thermoplastic materials * PE *PP * PVC * PMMA * SAN* PC* Nylon * PET.</p> <p>Properties and Uses of Thermosetting materials *PF* UF* MF* EPOXY* Polyester resin (SMC/DMC)</p> <p>Identification of plastic. Commodity, Engineering, Speciality</p> <p>Introduction to Alternate Materials for Additive Manufacturing- Clay, Porcelain, Ultemetc.</p>
6.	Basic Electricity: Introduction, Electric current - AC, DC, their comparison, voltage, resistance, their units. Conductor, insulator, Ohm’s Law. Types of connections – series, parallel and combined. Electric power, Horse power, energy, unit of electrical energy-kWh.
7.	Basic electronics:- Electron theory, Semiconductors, diodes, Transistors: PNP, NPN, Triode.
8.	Algebra : Addition, Subtraction, Multiplication, Division, Algebraic formula, Simple equations, Quadratic equations, Simultaneous equations (with two variables). Simple problems.
9.	Mensuration: Plane and Solid. Area and perimeter of triangle, square, rectangle, parallelogram, trapezium, polygons. Simple problems on regular and combined plane figures. Volume, Lateral surface area and total surface area of solids – cube, cuboid, prism,



	cylinder, cone, Sphere. Simple problems on regular and combined solids Volume of cut-out solids: hollow cylinders, frustum of cone, block section. Volume of simple machine blocks.
10.	Trigonometry: Trigonometrically ratios, measurement of angles. Value of trigonometric function for frequently used angles. Finding height and distance by trigonometry.
11.	Heat and Temperature: Heat and temperature, their units, difference between heat and temperature, boiling point, melting point, scales of temperature measurement, relation between different scale of temperature, Thermometer, pyrometer, transmission of heat. Methods of heat transmission - conduction, convection, radiation. Simple problems.
12.	Coordinate geometry: Introduction to coordinate geometry, Coordinate plane, origin of the plane, axis definition, coordinates of a point, distance between two points, Find the midpoint and, slope between two points.
13.	Number system:- Introduction, Decimal, binary, octal, hexadecimal BCD code, ASCII code, Bit, Byte, KB, MB, GB conversion.
14.	Estimation and costing:- Calculation of weight of material, material cost , machining cost, labour cost and total cost



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9.2 EMPLOYABILITY SKILLS:

CORE SKILL – EMPLOYABILITY SKILL	
First Year	
1. English Literacy	Duration : 20 hrs Marks : 09
Pronunciation	Accentuation (mode of pronunciation) on simple words, Diction (use of word and speech)
Functional Grammar	Transformation of sentences, Voice change, Change of tense, Spellings.
Reading	Reading and understanding simple sentences about self, work and environment
Writing	Construction of simple sentences Writing simple English
Speaking/ Spoken English	Speaking with preparation on self, on family, on friends/ classmates, on known people, picture reading, gain confidence through role- playing and discussions on current happening, job description, asking about someone's job, habitual actions. Cardinal (fundamental) numbers, ordinal numbers. Taking messages, passing on messages and filling in message forms, Greeting and introductions, office hospitality, Resumes or curriculum vita essential parts, letters of application reference to previous communication.
2. IT Literacy	Duration : 20 hrs Marks : 09
Basics of Computer	Introduction, Computer and its applications, Hardware and peripherals, Switching on-Starting and shutting down of the computer.
Computer Operating System	Basics of Operating System, WINDOWS, The user interface of Windows OS, Create, Copy, Move and delete Files and Folders, Use of External memory like pen drive, CD, DVD etc. Use of Common applications.
Word Processing and Worksheet	Basic operating of Word Processing, Creating, Opening and Closing Documents, Use of shortcuts, Creating and Editing of Text, Formatting the Text, Insertion & Creation of Tables. Printing document. Basics of Excel worksheet, understanding basic

	commands, creating simple worksheets, understanding sample worksheets, use of simple formulas and functions, Printing of simple excel sheets.
Computer Networking and Internet	Basic of Computer Networks (using real life examples), Definitions of Local Area Network (LAN), Wide Area Network (WAN), Internet, Concept of Internet (Network of Networks), Meaning of World Wide Web (WWW), Web Browser, WebSite, Web page and Search Engines. Accessing the Internet using Web Browser, Downloading and Printing Web Pages, Opening an email account and use of email. Social media sites and its implication. Information Security and antivirus tools, Do's and Don'ts in Information Security, Awareness of IT - ACT, types of cyber crimes.
3. Communication Skills	
	Duration : 15 hrs Marks : 07
Introduction to Communication Skills	Communication and its importance Principles of effective communication Types of communication - verbal, non-verbal, written, email, talking on phone. Non-verbal communication -characteristics, components-Para-language Body language Barriers to communication and dealing with barriers. Handling nervousness/ discomfort.
Listening Skills	Listening-hearing and listening, effective listening, barriers to effective listening, guidelines for effective listening. Triple- A Listening - Attitude, Attention & Adjustment. Active listening skills.
Motivational Training	Characteristics essential to achieving success. The power of positive attitude. Self awareness Importance of commitment Ethics and values Ways to motivate oneself Personal goal setting and employability planning.
Facing Interviews	Manners, etiquettes, dress code for an interview Do's & don'ts for an interview

Behavioral Skills	Problem solving Confidence building Attitude
4. Entrepreneurship Skills	
Duration : 15 hrs Marks : 06	
Concept of Entrepreneurship	Entrepreneur - Entrepreneurship - Enterprises: Conceptual issue Entrepreneurship vs. management, Entrepreneurial motivation. Performance & record, Role & function of entrepreneurs in relation to the enterprise & relation to the economy, Source of business ideas, Entrepreneurial opportunities, The process of setting up a business.
Project Preparation & Marketing Analysis	Qualities of a good entrepreneur, SWOT and risk analysis. Concept & Application of PLC, Sales & Distribution management. Difference between small scale & large scale business, Market survey, Method of marketing, Publicity and advertisement, Marketing mix.
Institution's Support	Preparation of project. Role of various schemes and institutes for self-employment i.e. DIC, SIDA, SISI, NSIC, SIDO, Idea for financing/ non-financing support agencies to familiarize with the policies / programmes, procedure & the available scheme.
Investment Procurement	Project formation, Feasibility, Legal formalities i.e., Shop act, Estimation & costing, Investment procedure - Loan procurement - Banking processes.
5. Productivity	
Duration : 10 hrs Marks : 05	
Benefits	Personal/ Workman - Incentive, Production linked Bonus, Improvement in living standard.
Affecting Factors	Skills, Working aids, Automation, Environment, Motivation - How it improves or slows down productivity.
Comparison with Developed Countries	Comparative productivity in developed countries (viz. Germany, Japan and Australia) in select industries, e.g. Manufacturing, Steel, Mining, Construction etc. Living standards of those countries, wages.
Personal Finance Management	Banking processes, Handling ATM, KYC registration, safe cash handling, Personal risk and insurance.
6. Occupational Safety, Health and Environment Education	
Duration : 15 hrs Marks : 06	
Safety & Health	Introduction to occupational safety and health

	Importance of safety and health at workplace.
Occupational Hazards	Basic hazards, chemical hazards, vibroacoustic hazards, mechanical hazards, electrical hazards, thermal hazards. occupational health, occupational hygiene, occupational diseases/ disorders & its prevention.
Accident & Safety	Basic principles for protective equipment. Accident prevention techniques - control of accidents and safety measures.
First Aid	Care of injured & sick at the workplaces, First-aid & transportation of sick person.
Basic Provisions	Idea of basic provision legislation of India. Safety, health, welfare under legislative of India.
Ecosystem	Introduction to environment. Relationship between society and environment, ecosystem and factors causing imbalance.
Pollution	Pollution and pollutants including liquid, gaseous, solid and hazardous waste.
Energy Conservation	Conservation of energy, re-use and recycle.
Global Warming	Global warming, climate change and ozone layer depletion.
Ground Water	Hydrological cycle, ground and surface water, Conservation and harvesting of water.
Environment	Right attitude towards environment, Maintenance of in-house environment.
7. Labour Welfare Legislation	
Duration : 05 hrs Marks : 03	
Welfare Acts	Benefits guaranteed under various acts- Factories Act, Apprenticeship Act, Employees State Insurance Act (ESI), Payment Wages Act, Employees Provident Fund Act, The Workmen's Compensation Act.
8. Quality Tools	
Duration : 10 hrs Marks : 05	
Quality Consciousness	Meaning of quality, Quality characteristic.

Quality Circles	Definition, Advantage of small group activity, objectives of quality circle, Roles and function of quality circles in organization, Operation of quality circle. Approaches to starting quality circles, Steps for continuation quality circles.
Quality Management System	Idea of ISO 9000 and BIS systems and its importance in maintaining qualities.
House Keeping	Purpose of housekeeping, Practice of good housekeeping.
Quality Tools	Basic quality tools with a few examples.



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LIST OF TOOLS & EQUIPMENT			
Additive Manufacturing Technician (3D Printing)			
S No.	Name of the Tools and Equipment	Specification	Quantity
A. Trainees Tool kit			
1.	Mini drafter, Tweezers, Gloves, Goggles, Scrapers		16 set
2.	Steel Rule Graduated both in Metric and English Unit		300 mm with precision of 1/4th mm
3.	Try Square		10 cm blade
4.	Caliper inside spring type		15 cm
5.	Caliper outside spring type		15 cm
6.	Divider spring type		15 m
B. DRAWING AND CAD LAB TOOLS			
1.	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.		16Nos
2.	Set square celluloid	45° (250 X 1.5 mm)	16 Nos
3.	Set square celluloid	30°-60° (250 X 1.5 mm)	16 Nos
4.	French-curves	set of 12 celluloid	16Nos.
5.	Drawing board	700mm x500 mm IS: 1444	16 set
6.	Chest of drawer 8 drawers	Standard	2 Nos.
7.	Draughtsman table		16 Nos.
8.	Draughtsman stool		16Nos.
9.	Desktop Computer Latest version compatible for running CAD software, preloaded with windows and 20" colour Monitor.	High end computer for scanner with 16 GB Ram and 2 GB Graphics card.	16+1 Nos
10.	Sever	True dedicated sever	1 No.
11.	Software: MS- office latest version, 3D CAD with latest Licensed version with SWIFT technology, support minimum 24 data translators, Should bi directional associative, , should facilitate the Additive Manufacturing technician with latest trends in Engineering costing which should be built	Re-engineering techniques software should be provided	17 users



	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.		
12.	Laser printer latest model	A3 size paper	1 No.
13.	UPS - 5 KVA for printing machine & computer		2 Nos.
14.	White Board for using LCD projector(optional)		1 No.
15.	Instructor Table		1 No.
16.	Instructor Chair		2 Nos.
17.	Almirah steel		1 No.
18.	Computer table		16+1Nos.
19.	Computer chairs		16+1Nos.
20.	Table for server, printers		1 No. each
21.	LCD projector /OHP		1 No.
22.	External storage device (8 TB)		2 Nos.
C. Tools & General Shop Outfit			
1.	Combination Plier Insulated	200 mm	03Nos.
2.	Screw Driver Insulated	4mm X 150 mm, Diamond Head	03Nos.
3.	Screw Driver Insulated	6mm X 150 mm	03Nos.
4.	Electrician screw driver thin stem insulated handle	4mm X 100 mm	03Nos.
5.	Heavy Duty Screw Driver insulated	5mm X 200 mm	03Nos.
6.	Electrician Screw Driver thin stem insulated handle	4mm X 250 mm	03Nos.
7.	Punch Centre	9mm X 150 mm	03Nos.
8.	Knife Double Bladed Electrician	100 mm	03Nos.
9.	Neon Tester	500 V	03Nos.
10.	Hammer, cross peen with handle	250 grams	04Nos.
11.	Electrical Symbol and Accessories Charts		04 Nos.
12.	Pipe vice Cast Iron with hardened jaw open type	100 mm	2 Nos.
13.	Hand Vice	50 mm jaw	2 Nos.
14.	Table Vice	100 mm jaw	2 Nos.
15.	Hacksaw frame (with blade)	Adjustable 300 mm Fixed 150 mm	2 Nos. Each
16.	File flat	200 mm 2nd cut with handle	3Nos.

17.	File half round	200 mm 2nd cut with handle	3Nos.
18.	File round	200 mm 2nd cut with handle	3Nos.
19.	Pliers long nose insulated	150 mm	3Nos.
20.	Pliers flat nose insulated	200 mm	4 Nos.
21.	Pliers, round nose insulated	100 mm	4 Nos.
22.	D.E. metric Spanner Double Ended	6 - 32 mm	2 Set
23.	Gauge, wire imperial stainless steel marked in SWG & mm	Wire Gauge - Metric	2 Nos.
24.	Portable Electric Drill Machine	0-12 mm capacity 750W, 240V with chuck and key	1 No.
D. MEASURING INSTRUMENT			
25.	Digital vernier caliper. (Universal type)	0 - 150 mm, LC 0.05 mm	1 no.
26.	Screw thread micrometer with interchangeable. Pitch anvils for checking metric threads 60.	0 - 25 mm LC 0.01 mm	1 no.
27.	Height micrometer	200 mm	1 no.
28.	Digital Micrometer outside.	0 - 100 mm L.C. 0.001 mm.	1 no.
29.	Digital Vernier caliper	0 - 200 mm L.C. 0.01 mm (Optional)	1no.
30.	Pillar Type Drilling machine	Sensitive 0-20 mm cap. with swivel table motorised with chuck & key.	1 no.
E. Tool list for Sensors			
31.	Power Supply	(0-30V DC, 3A)	1 no.
32.	Sensor Kit		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			
44.	3D Printer- with Continuous Filament Fabrication(CFF)	Build Volume - <u>320mm x 132mm x 154mm</u> with z resolution – 100 microns Software – Cloud based slicing software like Eiger/ Cura or similar software for printing composite materials	1 No.
45.	3D Printer- FFF (Fused Filament Fabrication)	200x300x200 PLA support	8 Nos.
46.	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.
47.	Scanner for Reverse Engineering-	Optical scanner tripod mounted with turn table and necessary accessories, accuracy up to 100 microns	1 No.
48.	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	1No.



		integration to integrate the model generated by reverse engineering software to the 3D CAD software. Create parametric model from .STL scan files	
G. SHOP FLOOR FURNITURE AND MATERIALS			
33.	Working Bench	2.5 m x 1.20 m x 0.75 m	04 Nos.
34.	Wiring Board	3 meters x 1 meter with 0.5 meter projection on the top	01 No.
35.	Metal Rack	100cm x 150cm x 45cm	04 Nos.
Note: - All the tools and equipment are to be procured as per BIS specification, consumables for yearly requirement			



TOOLS & EQUIPMENT FOR EMPLOYABILITY SKILLS		
S No.	Name of the Equipment	Quantity
1.	Computer (PC) with latest configurations and Internet connection with standard operating system and standard word processor and worksheet software	10 Nos.
2.	UPS - 500VA	10 Nos.
3.	Scanner cum Printer	1 No.
4.	Computer Tables	10 Nos.
5.	Computer Chairs	20 Nos.
6.	LCD Projector	1 No.
7.	White Board 1200mm x 900mm	1 No.

Note: - Above Tools & Equipments not required, if Computer LAB is available in the institute.



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FORMAT FOR INTERNAL ASSESSMENT

Name & Address of the Assessor:						Year of Enrollment:								
Name & Address of ITI (Govt./Pvt.):						Date of Assessment:								
Name & Address of the Industry:						Assessment location: Industry / ITI								
Trade Name:			Examination:			Duration of the Trade/course:								
Learning Outcome:														
S No.	Maximum Marks (Total 100 Marks)		15	5	10	5	10	10	5	10	15	15	Total Internal Assessment Marks	Result (Y/N)
	Candidate Name	Father's/Mother's Name	Safety Consciousness	Workplace Hygiene	Attendance/ Punctuality	Ability to follow Manuals/ Written instructions	Application of Knowledge	Skills to Handle Tools & Equipment	Economical use of Materials	Speed in doing work	Quality in Workmanship	VIVA		
1														
2														