Industrial Training Institute
Machinist

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

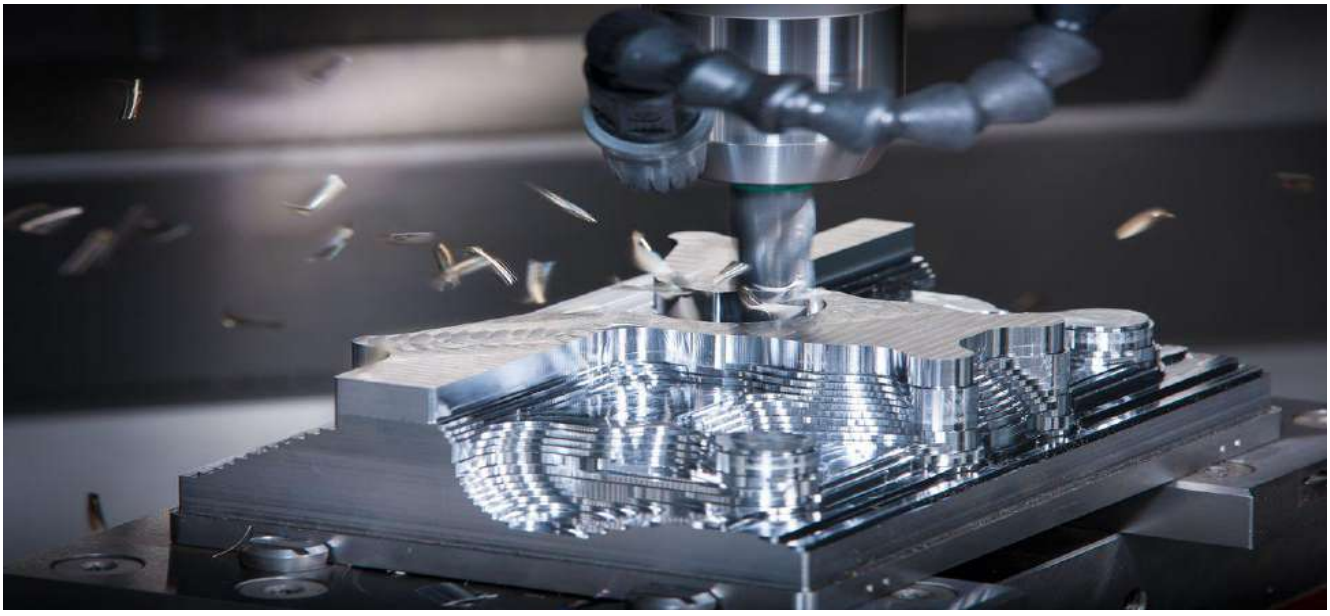
COMPETENCY BASED CURRICULUM

MACHINIST

(Duration: Two Years)

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL- 5



SECTOR – CAPITAL GOODS AND MANUFACTURING

Industrial Training Institute

Directorate General of Training

Skill India
कौशल भारत - कुशल भारत

MACHINIST

(Engineering Trade)

(Revised in 2018)

Version: 1.1

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL - 5

Developed By

Ministry of Skill Development and Entrepreneurship

Directorate General of Training

CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE

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List of Expert members contributed/ participated for finalizing the course curricula of Machinist trade held on 16.05.17 at Govt. ITI- Aundh, Pune			
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CONTENTS

1. COURSE INFORMATION

During the two years duration, a candidate is trained on subjects- Professional Skill, Professional Knowledge, Engineering Drawing, Workshop Science & Calculation and Employability Skills. In addition to this, a candidate is entrusted to make/do project work and Extra Curricular Activities to build up confidence. The practical skills are imparted in simple to complex manner & simultaneously theory subject is taught in the same fashion to apply cognitive knowledge while executing task. The broad components covered under Professional skill subject are as below: -

First Year – In this year, the contents covered are from safety aspect related to the trade, basic fitting operations viz., making, filing, sawing, chiseling, drilling, tapping, grinding to an accuracy of ±0.25mm. Making different fits viz., sliding, T-fit and square fit with an accuracy of ±0.2mm & angular tolerance of 1°. Lathe operation on different shaped job and produce components by different turning operation including thread cutting.

The practical training starts with operation of slotting machine and making different components to accuracy of ±0.04 mm. Followed by different operation in conventional milling machine with extensive coverage of different operations viz., plain, face, angular, form, gauge, straddle milling with accuracy ±0.02 mm like square thread cutting. Further advance turning operations with accuracy ±0.04 mm is covered. Next, the grinding operation (both surface and cylindrical) is executed with accuracy of ±0.01mm.

Second Year - In this year, grinding of different cutting tools are covered in the beginning followed by advance milling operation like boring, gear cutting, spline etc. to accuracy ±0.05mm. Basic electrical equipment and sensors are also covered and CNC turning operation which covers staring from setting, operation and programming part covered for producing different components.

The CNC milling operation is covered in the beginning which include setting, operation and part programming to producing different component. In addition to this, the components like documentation, technical English, simple repair and maintenance work, machining of some complicated components like bevel gears, plate components, worm wheel, worm thread etc. to an accuracy of ±0.05mm.

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 economy/ Labour market. The vocational training programmes are delivered under the aegis of 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.

Machinist trade under CTS is one of the popular courses delivered nationwide through a network of ITIs. The course is of two years duration. It mainly consists of Domain area and Core area. The Domain area (Trade Theory & 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 programme, the trainee is awarded National Trade Certificate (NTC) by NCVT which is recognized worldwide.

Candidates broadly need to demonstrate that they are able to:

- Read & interpret technical parameters/documentation, plan and organize work processes, identify necessary materials and tools;
- Perform task with due consideration to safety rules, accident prevention regulations and environmental protection stipulations;
- Apply professional knowledge, core skills & employability skills while performing the job and machining work.
- Check the job/components as per drawing for functioning, identify and rectify errors in job/components.
- Document the technical parameters related to the task undertaken.

2.2 CAREER PROGRESSION PATHWAYS:

- Can appear in 10+2 examination through National Institute of Open Schooling (NIOS) for acquiring higher secondary certificate and can go further for General/ Technical education.
- Can take admission in diploma course in notified branches of Engineering by lateral entry.

- Can join Apprenticeship programme in different types of industries leading to National Apprenticeship certificate (NAC).
- Can join Crafts Instructor Training Scheme (CITS) in the trade for becoming instructor in ITIs.

2.3 COURSE STRUCTURE:

Table below depicts the distribution of training hours across various course elements during a period of two years:

S No.	Course Element	Notional Training Hours
1	Professional Skill (Trade Practical)	2209
2	Professional Knowledge (Trade Theory)	510
3	Workshop Calculation & Science	170
4	Engineering Drawing	255
5	Employability Skills	110
6	Library & Extracurricular Activities	146
7	Project Work	240
8	Revision & Examination	520
	Total	**4160**

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 itself.

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 have to maintain 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.

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 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 assessment. Due consideration should be given while assessing for teamwork, avoidance/reduction of scrap/wastage and disposal of scrap/wastage as per procedure, behavioral attitude, sensitivity to 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	• Demonstration of good skill in the use of hand tools, machine tools and workshop equipment.

demonstrates attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and practices.	• 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) 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 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) Weightage in the range of above 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

Brief description of job roles:

Machinist General operates various types of power driven metal cutting or grinding machines for cutting and grinding metal. Studies drawings or measures out sample with appropriate measuring instruments to note different dimensions and sequence of operations required. Selects metal piece and marks it or gets it marked for machining operations required. Fastens metal in chuck, jig or other fixture and respective tool or cutter, according to sequence of operation, on appropriate machine (lathe, shaper, milling, slotting, drilling, grinding).Checks machine setting or sets it for stipulated machine operations. Selects machine feed and speed and starts machine. Controls flow of coolant (cutting lubricant) and manipulates hand wheels or applies automatic controls to feed tool to metal or metal to tool. Observes cutting or grinding both from marking and machine readings, checks for dimensions as necessary and removes parts when machining is completed, checks completed part with measuring instruments and gauges to ensure prescribed accuracy. Makes adjustments if necessary and repeats operations, as required, on same or other machines. May assist in setting up machine for repetitive work, change tools, make simple adjustments, clean and oil machine.Does process planning, tool and cutting parameters selection, programming, setup and operation for cutting parts on CNC vertical machining center and CNC lathe.

Plan and organize assigned work, detect & resolve issues during execution. Demonstrate possible solutions and agree tasks within the team. Communicate with required clarity and understand technical English. Sensitive to environment, self-learning and productivity.

May be designated as **Machinist** according to nature of work done.

Reference NCO-2015:

i) 7223.0500
ii) 7224.0100

4. GENERAL INFORMATION

Name of the Trade	**Machinist**
NCO - 2015	7223.0500, 7224.0100
NSQF Level	Level – 5
Duration of Craftsmen Training	Two years
Entry Qualification	Passed 10th Class with Science and Mathematics or its equivalent
Unit Strength (No. Of Students)	20
Space Norms	130 Sq. m
Power Norms	20 KW
Instructors Qualification for	
1. Machinist Trade	Degree in Mechanical Engineering from recognized Engineering College/university with one year experience in the relevant field. **OR** Diploma in Mechanical Engineering from recognized board of technical education with two-year experience in the relevant field. **OR** NTC/NAC passed in the Trade of "Machinist" With three- year post qualification experience in the relevant field. **Essential Qualification:** Craft Instructor Certificate in relevant trade under NCVT. ***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.***
2. Workshop Calculation & Science	Degree in Engineering with one year experience. **OR** Diploma in Engineering with two-year experience. **Essential Qualification:** Craft Instructor Certificate in RoD&A course under NCVT.
3. Engineering Drawing	Degree in Engineering with one year experience. **OR** Diploma in Engineering with two-year experience.

	OR NCVT/ NAC in the Draughtsman (Mechanical) with three-year experience. **<u>Essential Qualification</u>:** Craft Instructor Certificate in RoD&A course under NCVT.
4. Employability Skill	MBA OR BBA with two-year experience OR Graduate in Sociology/ Social Welfare/ Economics with two-year experience OR Graduate/ Diploma with two-year experience and trained in Employability Skills from DGT institutes. **AND** Must have studied English/ Communication Skills and Basic Computer at 12th/ Diploma level and above. **OR** **Existing Social Studies Instructors duly trained in Employability Skills from DGT institutes.**
List of Tools and Equipment	As per Annexure – I

Distribution of training on Hourly basis: (Indicative only)

Total Hours/Week	Trade Practical	Trade Theory	Work shop Cal. &Sc.	Engg. Drawing	Employability Skills	Extra-curricular Activity
40 Hours	25 Hours	6 Hours	2 Hours	3 Hours	2 Hours	2 Hours

5. NSQF LEVEL COMPLIANCE

NSQF level for **Machinist** trade under CTS: **Level 5**

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 and
e. Responsibility

The broad learning outcome of **Machinist** trade under CTS mostly matches with the Level descriptor at Level - 5.

The NSQF level-5 descriptor is given below:

Level	Process Required	Professional Knowledge	Professional Skill	Core Skill	Responsibility
Level 5	Job that requires well developed skill, with clear choice of procedures in familiar context.	Knowledge of facts, principles, processes and general concepts, in a field of work or study.	A range of cognitive and practical skills required to accomplish tasks and solve problem by selecting and applying basic methods, tools, materials and information.	Desired mathematical skill, understanding of social, political and some skill of collecting and organizing information, communication.	Responsibility for own work and learning and some responsibility for other's works and learning.

6. LEARNING 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. Recognize & comply with safe working practices, environment regulation and housekeeping.

2. Understand and explain different mathematical calculation & science in the field of study including basic electrical. *[Different mathematical calculation & science-Work, Power & Energy, Algebra, Geometry & Mensuration, Trigonometry, Heat & Temperature, Levers & Simple machine, graph, Statistics, Centre of gravity, Power transmission, Pressure]*

3. Interpret specifications, different engineering drawing and apply for different application in the field of work. *[Different engineering drawing-Geometrical construction, Dimensioning, Layout, Method of representation, Symbol, scales, Different Projections, Machined components & different thread forms, Assembly drawing, Sectional views, Estimation of material, Electrical & electronic symbol]*

4. Select and ascertain measuring instrument and measure dimension of components and record data.

5. Explain the concept in productivity, quality tools, and labour welfare legislation and apply such in day-to-day work to improve productivity & quality.

6. Explain energy conservation, global warming and pollution and contribute in day-to-day work by optimally using available resources.

7. Explain personnel finance, entrepreneurship and manage/ organize related task in day-to-day work for personal & societal growth.

8. Plan and organize the work related to the occupation.

6.2. SPECIFIC LEARNING OUTCOME

First Year

9. 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, Hack sawing, Chiselling, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm]
10. Produce components by different operations and check accuracy using appropriate measuring instruments.[Different Operations - Drilling, Reaming, Tapping, Dieing; Appropriate Measuring Instrument – Vernier, Screw Gauge, Micrometer]
11. Make different fit of components for assembling as per required tolerance observing principle of interchangeability and check for functionality. [Different Fit – Sliding, Angular, Step fit, 'T' fit, Square fit and Profile fit; Required tolerance: ±0.2 mm, angular tolerance: 1 degree.]
12. Set different shaped jobs on different chuck and demonstrate conventional lathe machine operation observing standard operation practice. [Different chucks: 3 jaws & 4 jaws, different shaped jobs: round, square, hexagonal]
13. Prepare different cutting tool to produce jobs to appropriate accuracy by performing different turning operations. *[Different cutting tool – V tool, side cutting, parting, thread cutting (both LH & RH), Appropriate accuracy: - ±0.06mm, Different turning operation – Plain, facing, drilling, boring (counter & stepped), grooving, Parallel Turning, Step Turning, parting, chamfering, U -cut, Reaming, knurling.]*
14. Set different components of machine & parameters to produce taper/ angular components and ensure proper assembly of the components. *[Different component of machine: Form tool, Compound slide, tail stock offset; Different machine parameters- Feed, speed, depth of cut.]*
15. Set the different machining parameters to produce metric-v threaded components applying method/ technique and test for proper assembly of the components.
16. Set the different machining parameters and cutting tool to prepare job by performing different slotting operation. *[Different machining parameters – feed, speed and depth of cut. Different slotting operations–concave & convex surface, internal key ways, profiling, making internal sprocket with an accuracy of +/- 0.04 mm]*
17. Set the different machining parameters and cutters to prepare job by performing different milling operation and indexing. [Different machining parameters – feed, speed and depth of cut. Different milling operations – plain, face, angular, form, gang, straddle milling]
18. Set the different machining parameters to produce square & "V'' threaded components applying method/ technique and test for proper assembly of the components.
19. Produce components of high accuracy by different operations using grinding. [*Different operations – surface grinding, cylindrical grinding with an accuracy of+/- 0.01 mm*]

Second Year

20. Resharpen different single & multipoint cutting tool. [Different single point tools, slab milling cutter, side & face milling cutter, end mill cutter and shell end mill cutter.]
21. Set different machining parameters and cutters to prepare job by different milling machine operations. *[Different machining parameters - feed, speed, depth of cut, different machining operation – facing, drilling, tapping, reaming, counter boring, counter sinking, spot facing, and boring slot cutting.**]***
22. Set the different machining parameters and cutters to prepare components by performing different milling operation and indexing. *[Different machining parameters – feed, speed and depth of cut. Different components – Rack, Spur Gear, External Spline, Steel Rule, Clutch**,** Helical Gear]*
23. 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.*]
24. Set (both job and tool) CNC turning centre and produce components as per drawing by preparing part programme.
25. Set (both job and tool) CNC machining centre and produce components as per drawing by preparing part programme.
26. Plan and perform simple repair, overhauling of different machines and check for functionality. *[Different Machines – Drilling Machine, milling machine and Lathe]*
27. Set the different machining parameters and cutters to prepare components by performing different milling operation and indexing. *[Different machining parameters – feed, speed and depth of cut. Different components – end mill, bevel gear, cam, worm & worm wheel]*

7. LEARNING OUTCOME WITH ASSESSMENT CRITERIA

GENERIC LEARNING OUTCOME	
LEARNING OUTCOME	**ASSESSMENT CRITERIA**
1. Recognize & comply with safe working practices, environment regulation and housekeeping.	1.1 Follow and maintain procedures to achieve a safe working environment in line with occupational health and safety regulations and requirements.
	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/unsalvageable 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.
	1.12 Identify environmental pollution & contribute to avoidance of same.
	1.13 Take opportunities to use energy and materials in an environmentally friendly manner.
	1.14 Avoid waste and dispose waste as per procedure.
	1.15 Recognize different components of 5S and apply the same in the working environment.

2. Understand, explain different mathematical calculation & science in the field of study including basic electrical and apply in day-to-day work.*[Different mathematical calculation & science -Work, Power & Energy, Algebra, Geometry & Mensuration, Trigonometry, Heat & Temperature, Levers & Simple machine, graph, Statistics, Centre of gravity, Power transmission, Pressure]*	2.1 Explain concept of basic science related to the field such as Material science, Mass, weight, density, speed, velocity, heat & temperature, force, motion, pressure, heat treatment, centre of gravity, friction.
	2.2 Measure dimensions as per drawing.
	2.3 Use scale/ tapes to measure for fitting to specification.
	2.4 Comply given tolerance.
	2.5 Prepare list of appropriate materials by interpreting detail drawings and determine quantities of such materials.
	2.6 Ensure dimensional accuracy of assembly by using different instruments/gauges.
	2.7 Explain basic electricity, insulation &earthing.
3. Interpret specifications, different engineering drawing and apply for different application in the field of work. *[Different engineering drawing-Geometrical construction, Dimensioning, Layout, Method of representation, Symbol, scales, Different Projections, Machined components & different thread forms, Assembly drawing, Sectional views, Estimation of material, Electrical & electronic symbol]*	3.1 Read & interpret the information on drawings and apply in executing practical work.
	3.2 Read & analyse the specification to ascertain the material requirement, tools, and machining/ assembly/maintenance parameters.
	3.3 Encounter drawings with missing/unspecified key information and make own calculations to fill in missing dimension/parameters to carry out the work.
4. Select and ascertain measuring instrument and measure dimension of components and record data.	4.1 Select appropriate measuring instruments such as micrometers, verniercalipers, dial gauge, bevel protector and height gauge (as per tool list).
	4.2 Ascertain the functionality & correctness of the instrument.
	4.3 Measure dimension of the components & record data to analyse withthe given drawing/measurement.

5. Explain the concept in productivity, quality tools, and labour welfare legislation and apply such in day-to-day work to improve productivity & quality.	5.1 Explain the concept of productivity and quality tools and apply during execution of job.
	5.2 Understand the basic concept of labour welfare legislation and adhere to responsibilities and remain sensitive towards such laws.
	5.3 Knows benefits guaranteed under various acts.
6. Explain energy conservation, global warming, pollution and contribute in day-to-day work by optimally using available resources.	6.1 Explain the concept of energy conservation, global warming, pollution and utilize the available resources optimally & remain sensitive to avoid environment pollution.
	6.2 Dispose waste following standard procedure.
7. Explain personnel finance, entrepreneurship and manage/ organize related task in day-to-day work for personal & societal growth.	7.1 Explain personnel finance and entrepreneurship.
	7.2 Explain 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.
	7.3 Prepare Project report to become an entrepreneur for submission to financial institutions.
8. Plan and organize the work related to the occupation.	8.1 Use documents, drawings and recognize hazards in the work site.
	8.2 Plan workplace/ assembly location with due consideration to operational stipulation.
	8.3 Communicate effectively with others and plan project tasks.
	8.4 Assign roles and responsibilities of the co-trainees for execution of the task effectively and monitor the same.

SPECIFIC LEARNING OUTCOME	
LEARNING OUTCOME	**ASSESSMENT CRITERIA**
First Year	
9. 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, Hack sawing, Chiselling, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm]	9.1 Plan & identify tools, instruments and equipment for marking and make this available for use in a timely manner.
	9.2 Select raw material and visual inspection for defects.
	9.3 Mark as per specification applying desired mathematical calculation and observing standard procedure.
	9.4 Measure all dimensions in accordance with standard specifications and tolerances.
	9.5 Identify hand tools for different fitting operations and make these available for use in a timely manner.
	9.6 Prepare the job for Hacksawing, chiselling, filing, drilling, tapping, grinding.
	9.7 Perform basic fitting operations viz., Hacksawing, filing, drilling, tapping and grinding to close tolerance as per specification to make the job.
	9.8 Observe safety procedure during above operation as per standard norms and company guidelines.
	9.9 Check for dimensional accuracy as per standard procedure.
	9.10 Avoid waste, ascertain unused materials and components for disposal, store these in an environmentally appropriate manner and prepare for disposal.
10. Produce components by different operations and check accuracy using appropriate measuring instruments.[Different Operations - Drilling, Reaming, Tapping, Dieing; Appropriate Measuring Instrument – Vernier, Screw Gauge, Micrometer]	10.1 Plan and organize to produce different components.
	10.2 Select raw material, tools &equipments as per drawing.
	10.3 Execute/ perform different operations such as counter sinking counter boring and reaming, tapping, dieing etc.
	10.4 Check the work/ job using vernier, screw gauge micrometer and rectify if necessary.

11. Make different fit of components for assembling as per required tolerance observing principle of interchangeability and check for functionality. [Different Fit – Sliding, Angular, Step fit, 'T' fit, Square fit and Profile fit; Required tolerance: ±0.2 mm, angular tolerance: 1 degree.]	11.1 Plan and organize for fitting job.
	11.2 Select raw material, tools &equipments.
	11.3 Perform the work pieces for fitting according to tolerances and interchangeability.
	11.4 Check all dimensions and interchangeability in accordance with drawing and rectify if required.
12. Set different shaped jobs on different chuck and demonstrate conventional lathe machine operation observing standard operation practice. [Different chucks: 3 jaws & 4 jaws, different shaped jobs: round, square, hexagonal]	12.1 Identify and acquaint with lathe machine operation with its components.
	12.2 Identify different work holding devices and acquaint with functional application of each device.
	12.3 Mount the appropriate work holding device and check for its functional usage to perform turning operations.
	12.4 Set the job on chuck as per shape.
	12.5 Set the lathe on appropriate speed & feed.
	12.6 Operate the lathe to demonstrate lathe operation, observing standard operating practice.
	12.7 Observe safety procedure during above operation as per standard norms and company guidelines.
13. Prepare different cutting tool to produce jobs to appropriate accuracy by performing different turning operations. *[Different cutting tool – V tool, side cutting, parting, thread cutting (both LH & RH), Appropriate accuracy: - ±0.06mm, Different turning operation – Plain, facing, drilling, boring (counter & stepped), grooving, Parallel*	13.1 Identify cutting tool materials used on lathe machine as per the specification and their application.
	13.2 Plan and grind cutting tools.
	13.3 Measure the tool angles with gauge and Bevel protractor as per tool signature.
	13.4 Mount the job and set machine parameter.
	13.5 Perform turning operations viz., *facing, Parallel Turning, Step Turning, chamfering, grooving, U-cut, parting, drilling, boring (counter & stepped),Reaming, internal recess and knurling to make component as per specification.*
	13.6 Check accuracy/ correctness of job using appropriate gauge and measuring instruments for their functional requirement.

Turning, Step Turning, parting, chamfering, U -cut, Reaming, knurling.]	13.7 Avoid waste, ascertain unused materials and components for disposal, store these in an environmentally appropriate manner and prepare for disposal.
14. Set different components of machine & parameters to produce taper/ angular components and ensure proper assembly of the components. *[Different component of machine: Form tool, Compound slide, tail stock offset; Different machine parameters- Feed, speed, depth of cut.]*	14.1 Plan and select appropriate method to produce taper/ angular components.
	14.2 Evaluate angles to set up the tool and machine component for machining.
	14.3 Demonstrate possible solutions and agree tasks within the team.
	14.4 Produce taper/ angular components as per standard operating procedure.
	14.5 Check accuracy/ correctness of job using appropriate gauge and measuring instruments for their functional requirement.
	14.6 Assemble the components to ascertain functionality.
15. Set the different machining parameters to produce metric-v threaded components applying method/ technique and test for proper assembly of the components.	15.1 Plan and select appropriate method to produce threaded components.
	15.2 Plan and prepare thread cutting tool in compliance with standard thread parameters.
	15.3 Produce components as per drawing.
	15.4 Check accuracy/ correctness of job using appropriate gauge and measuring instruments for their functional requirement and suit to male/female part.
	15.5 Test the proper assembly of the threaded components.
16. Set the different machining parameters and cutting tool to prepare job by performing different slotting operation. *[Different machining parameters – feed, speed and depth of cut. Different slotting operations – concave & convex surface, internal key ways, profiling, making internal sprocket with an accuracy of +/-*	16.1 Identify different work and tool holding devices and acquaint with functional application of each device.
	16.2 Mount the work and tool holding devices with required alignment and check for its functional usage to perform slotting operations.
	16.3 Observe safety procedure during mounting as per standard norms.
	16.4 Select appropriate tools and equipment and operate the machine to produce components as per required dimension.
	16.5 Solve problem by applying basic methods, tools, materials and information during setting machining.
	16.6 Avoid waste and dispose waste as per procedure.

0.04 mm]	16.7 Measure all dimensions to check for accuracy with respect to the drawing.
17. Set the different machining parameters and cutters to prepare job by performing different milling operation and indexing. [Different machining parameters – feed, speed and depth of cut. Different milling operations – plain, face, angular, form, gang, straddle milling]	17.1 Identify different work and tool holding devices and acquaint with functional application of each device.
	17.2 Mount the work and tool holding devices with required alignment and check for its functional usage to perform milling operations.
	17.3 Observe safety procedure during mounting as per standard norms.
	17.4 Solve problem by applying desired mathematical skill, basic methods, tools, materials and collect and organize information during setting.
18. Set the different machining parameters to produce square & "V'' threaded components applying method/ technique and test for proper assembly of the components.	18.1 Plan and select appropriate method to produce components with different forms of thread.
	18.2 Plan and prepare thread cutting tool in compliance with standard thread parameters.
	18.3 Apply desired mathematical skills, collect and organize information to work out the machining parameters.
	18.4 Produce components as per drawing.
	18.5 Check accuracy/ correctness of job using appropriate gauge and measuring instruments for their functional requirement and suit to male/female part.
19. Produce components of high accuracy by different operations using grinding. [*Different operations – surface grinding, cylindrical grinding with an accuracy of+/- 0.01 mm*]	19.1 Plan and select appropriate method to produce the work piece as per drawing.
	19.2 Select appropriate tools, equipment and machine to produce the work piece as per drawing and make these available for use in a timely manner.
	19.3 Grind the cutting tool following standard operating practice.
	19.4 Set the job on grinding machine and grind the surfaces as per specification/drawing (parallel and stepped) following standard operating practice.
	19.5 Check the dimension of parallel and stepped job by precession instrument. (micrometer)
	19.6 Observe safety precautions during operation ofmachine.
	19.7 Check for desired performance

Second Year	
20. Resharpen different single & multipoint cutting tool. [Different single point tools, slab milling cutter, side & face milling cutter, end mill cutter and shell end mill cutter.]	20.1 Plan and select appropriate method to re-sharpen the tool.
	20.2 Set the tool and appropriate accessories/ attachments observing safety/ precautions to re-sharpen the tool as per standard method of operation.
	20.3 Perform the operation as per standard method.
	20.4 Check the accuracy.
21. Set different machining parameters and cutters to prepare job by different milling machine operations. *[Different machining parameters - feed, speed, depth of cut, different machining operation – facing, drilling, tapping, reaming, counter boring, counter sinking, spot facing, andboring slot cutting.]*	21.1 Plan &select appropriate cutter according to standard of operation.
	21.2 Setting of cutter and machining parameters.
	21.3 Produce components by performing different milling operations/ indexing.
	21.4 Checking the accuracy/ correctness with instruments/ gauges and rectify if required.
22. Set the different machining parameters and cutters to prepare components by performing different milling operation and indexing. *[Different machining parameters – feed, speed and depth of cut. Different components – Rack, Spur Gear, External Spline, Steel Rule, Clutch,*	22.1 Select cutter as per specification of gear and plan to make spur gear, helical,rack & pinion as per drawing.
	22.2 Comply with safety rules when performing the above operations.
	22.3 Work out and apply indexing parameters as per different components to be produced to determine gear setting and set indexing head, milling machine.
	22.4 Demonstrate possible solutions within the team using desired mathematical skills, knowledge of facts, principles, processes and general concept in the field of work to set the indexing head.
	22.5 Solve problems during operation by selecting and applying basic methods, tools, materials and collect and organize information for quality output.

Helical Gear]	22.6 Set job and produce component following the standard operating procedure.
	22.7 Make components observing standard operating procedure.
	22.8 Measure with instruments/gauges as per drawing and check functionality of gear.
	22.9 Avoid waste, ascertain unused materials and components for disposal, store these in an environmentally appropriate manner and prepare for disposal.
23. 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.*]	23.1 Identify differnet electrical equipment vizmulti-meter, transformer, relays, solenoids, motor & generator.
	23.2 Identify differnet sensors viz, proximity &ultrasonic.
	23.3 Examine functioning of different electrical equipment, sensors and their utilization in industrial application.
	23.4 Observe safety precautions during examination of electrical equipment and sensors.
24. Set (both job and tool) CNC turning centre and produce components as per drawing by preparing part programme	24.1 Plan and prepare part programme as per drawing, simulate for its correctness with appropriate software.
	24.2 Prepare tooling layout and select tools as required.
	24.3 Demonstrate possible solution within the team.
	24.4 Set selected tools on to the machine.
	24.5 Test/Dry run the part programme on the machine.
	24.6 Set up the job and machine the component as per standard operating procedure involving parallel, step, taper, drilling, boring, radius, grooving and threading operations, etc.
	24.7 Check accuracy/ correctness of job using appropriate gauge and measuring instruments.
	24.8 Observe safety/ precaution during machining.

	24.9 Avoid wastage, ascertain unused materials and components for disposal, store these in an environmentally appropriate manner and prepare for disposal.
25. Set (both job and tool) CNC machining centre and produce components as per drawing by preparing part programme	25.1 Plan and prepare part programme as per drawing applying range of cognitive and practical skills, simulate for its correctness with simulation software.
	25.2 Demonstrate possible solutions within the team.
	25.3 Prepare tooling layout and select tools as required.
	25.4 Set selected tools on to the machine.
	25.5 Test/Dry run the part programme on the machine.
	25.6 Set up the job and produce the component as per standard operating procedure involving face milling, contour milling with tool radius compensation, pocket milling, drilling, peck drilling, countersinking, tapping operations using canned cycle for hole operations.
	25.7 Solve problems during operation by selecting and applying basic methods, tools, materials and information and using quality concept.
	25.8 Check accuracy/ correctness of job using appropriate gauge and measuring instruments.
	25.9 Observe safety/ precaution during machining.
26. Plan and perform simple repair, overhauling of different machines and check for functionality. *[Different Machines – Drilling Machine, milling machine and Lathe]*	26.1 Ascertain and select tools and materials for the repair, overhauling and make this available for use in a timely manner.
	26.2 Plan work in compliance with standard safety norms.
	26.3 Demonstrate possible solutions and agree tasks within the team.
	26.4 Select specific parts to be repaired and ascertain for appropriate material and estimated time.
	26.5 Repair, overhaul and assemble the parts in the machine with the help of blue print.
	26.6 Check for functionality of part and ascertain faults of the part/ machine in case of improper function.
	26.7 Rectify faults of assembly.
27. Set the different machining parameters and cutters to	27.1 Select cutter as per specification of job and plan to make end mill, bevel gear, cam, worm & worm wheel as per drawing.

prepare components by performing different milling operation and indexing. *[Different machining parameters – feed, speed and depth of cut. Different components – end mill, bevel gear, cam, worm & worm wheel]*	27.2 Comply with safety rules when performing the above operations.
	27.3 Demonstrate possible solutions within the team.
	27.4 Solve problems during operation by selecting and applying basic methods, tools, materials and information and using quality concept.
	27.5 Apply mathematical skill, knowledge of facts, principles, processes and general concepts in the field of work to determine gear setting and set indexing head, milling machine.
	27.6 Set job and produce component following the standard operating procedure.
	27.7 Make components observing standard operating procedure.
	27.8 Measure with instruments/gauges as per drawing and check functionality of component.

8. SYLLABUS

SYLLABUS - MACHINIST			
First Year			
Week No.	**Reference Learning Outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
1.	Recognize & comply with safe working practices, environment regulation and housekeeping.	1. Importance of trade training, List of tools & Machinery used in the trade.(01hr) 2. Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). (05 hrs.) 3. First Aid Method and basic training.(02 hrs.) 4. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. (02 hrs.) 5. Hazard identification and avoidance. (02 hrs.) 6. Identification of safety signs for Danger, Warning, caution & personal safety message.(01 hr) 7. Preventive measures for electrical accidents & steps to be taken in such accidents.(02 hrs.) 8. Use of fire extinguishers.(07 hrs.) 9. Practice and understand precautions to be followed while working in fitting jobs. (02 hrs.) 10. Safe use of tools and equipments used in the trade. (01 hr)	All necessary guidance to be provided to the newcomers to become familiar with the working of Industrial Training Institute system including store's procedures. Soft skills, its importance and job area after completion of training. Importance of safety and general precautions observed 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.
2.	Plan and organize the work to make job as per specification applying different types of basic fitting operation and check	11. Study the drawing to plan the job/ work. Identification of tools &equipments as per desired specifications for marking, filing& sawing. (03 hrs.) 12. Visual inspection of raw material for rusting, scaling, corrosion	Linear measurements- its units, steel rule dividers, callipers – types and uses, Punch – types and uses. Uses of different types of hammers. Description, use and care of marking off table.

	for dimensional accuracy. [Basic fitting operation – marking, Hack sawing, Chiselling, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm]	etc.(01 hr) 13. *Familiarisation of bench vice* (01 hr) 14. *Filing- Flat and square (Rough finish), (08 hrs.)* 15. *Marking with scriber and steel rule (2hrs..)* 16. Filing practice, surface filing, marking of straight and parallel lines with odd leg calipers and steel rule. (10 hrs..)	
3.	-do-	17. Marking out lines, gripping suitably in vice jaws, hack sawing to given dimensions. (10 hrs.) 18. Sawing different types of metals of different sections. (10 hrs.) 19. Marking practice with dividers, odd leg callipers, scriber and steel rule (circles, arc,parallel lines). (05 hrs.)	Bench vice construction, types, uses, care & maintenance, vice clamps, hacksaw frames and blades, specification, description, types and their uses, method of using hacksaws. Files- elements, types, specification and their uses. Methods of filing. Care and maintenance of files. Measuring standards (English, Metric Units)
4.	-do-	20. *Grinding, centre punch, dot punch, chisel and scriber.(05hrs.)* 21. Marking off straight lines and arcusing scribing block and dividers. (05 hrs.) 22. Marking, filing, filing square and check using try-square. (15 hrs.)	Pedestal grinding machine: Use, care and safety aspect. Marking off and layout tools, scribing block, care & maintenance. Try square, ordinary depth gauge, Care & maintenance of cold chisels- materials, types, cutting angles. Combination set- its components, uses and cares.
5.	-do-	23. Marking according to drawing for locating, position of holes, scribing lines on chalked surfaces with marking tools. (05 hrs.) 24. Finding centre of round bar with the help of 'V' block and marking block. (05 hrs.) 25. Prepare mushroom head and round bar and bending metal plate by hammering. (15hrs.) 26. Marking using scale, surface gauge and angle plate.	Marking media, Prussian blue, red lead, chalk and their special application, description. Surface plate and auxiliary marking equipment, 'V' block, angle plates, parallel block, description, types, uses, accuracy, care and maintenance.
6 &7	-do-	27. *Chipping flat surfaces along a*	Drill, Tap,Die-types & application.

		marked line. (10 hrs.) 28. *Make a square from a round job by chipping upto 20mm length. (08hrs.)* 29. *Slot, straight and angular chipping. (07hrs.)* 30. Mark off and drill through holes. (07 hrs.) 31. Drill and tap on M.S. flat. (08 hrs.) 32. Cutting external thread on M.S. rod using Die.(05hrs.) 33. Punch letter and number (letter punch and number punch). (05 hrs.)	Determination of tap drill size. Basic terminology related to screw thread. Reamer- material, types (Hand and machine reamer), parts and their uses, determining hole size for reaming, Reaming procedure. Vernier height gauge: construction, graduations, vernier setting & reading. Care and maintenance of Vernier height Gauge.
8&9	Make different fit of components for assembling as per required tolerance observing principle of interchangeability and check for functionality. [Different Fit – Sliding, 'T' fitand Square fit; Required tolerance: ±0.2 mm, angular tolerance: 1 degree.]	34. Make Male & Female 'T' fitting with an accuracy +/- 0.2 mm and 1 degree. (25hrs.) 35. Make male female square fit with accuracy +/- 0.1 mm. (25hrs.)	Interchangeability: Necessity in Engg, field, Limit- Definition, types, terminology of limits and fits-basic size, actual size, deviation, high and low limit, zero line, tolerance zone, allowances. Different standard systems of fits and limits. (British standard system & BIS system)
10& 11	-do-	36. Make Male & Female Hexagon fitting with accuracy +/- 0.06 mm. (50 hrs.)	Vernier calliper-its parts, principle, reading, uses & care. Outside micrometer- its parts, principle, reading, uses, Reading of Vernier Micrometer), care & maintenance. Dial test indicator-its parts, types, construction and uses.
12	Produce components by different operations and check accuracy using appropriate measuring instruments.[Different	37. Counter sinking, counter boring and reaming with accuracy +/- 0.04 mm.(05 hrs.) 38. Drill blind holes with an accuracy 0.04 mm.(02 hrs.) 39. Form internal threads with taps to standard size (blind holes).(03	Drilling machines-types &their application, construction of Pillar & Radial drilling machine. Countersunk, counter bore and spot facing-tools and nomenclature. Cutting Speed, feed, depth of cut and Drilling time calculations.

	Operations - Drilling, Reaming, Tapping, Dieing; Appropriate Measuring Instrument – Vernier, Screw Gauge, Micrometer]	hrs.) 40. Prepare studs and bolt. (15 hrs.)	
13	Set different shaped jobs on different chuck and demonstrate conventional lathe machine operation observing standard operation practice. [Different chucks: 3 jaws & 4 jaws, different shaped jobs: round, square, hexagonal]	41. Identify & function of different parts of lathe. Practice on operation of lathe (dry/idle run). (10 hrs.) 42. Setting lathe on different speed and feed.(05 hrs.) 43. Dismantling, assembling & truing of 3-jaw & 4-jaw chucks. (10hrs.)	Getting to know the lathe with its main components, lever positions and various lubrication points as well. Definition of machine & machine tool and its classification. History and gradual development of lathe. Introduction to lathe- its types. Centre lathe construction, detail function of parts, specification. Safety points to be observed while working on a lathe.
14	Prepare different cutting tool to produce jobs to appropriate accuracy by performing different turning operations. *[Different cutting tool – V tool, side cutting, parting, thread cutting (both LH& RH), Appropriate accuracy: ±0.06mm, Different turning operation – Plain, facing, drilling, boring (counter & stepped), grooving, Parallel Turning, Step Turning,*	44. Grinding of R.H. and L.H. tools, V-tool, parting tool, Round nose tool. (15 hrs.) 45. Checking of angles with angle gauge/ bevel protractor. (02 hrs.) 46. Grinding of "V" tools for threading of Metric 60 degree threads. (08 hrs.)	Lathe cutting tool-different types, material, shapes and different angles (clearance, rake etc.) and their effects, specification of lathe tools, grinding process of tools. Types of chips, chip breaker. Tool life, factors affecting tool life.

	parting, chamfering, U -cut, Reaming, knurling.]		
15	-do-	47. Perform facing operation to correct length.(05 hrs.) 48. Centre drilling and drilling operation to required size.(05 hrs.) 49. Perform parallel turning and step turning operation. (15 hrs.)	Driving mechanism, speed and feed mechanism of Lathe.
16& 17	-do-	50. Perform drilling, boring and undercut operation, parting, grooving, chamfering practice. (48 hrs.) 51. Measurement with steel rule and outside calliper with an accuracy of ± 0.5 mm. (02 hrs.)	Concept of Orthogonal and Oblique Cutting. Chucks & different types of job holding devices on lathe and advantages of each type. Mounting and dismounting of chucks. Vernier Bevel Protractor – parts, reading and uses.
18	-do-	52. Perform different Knurling operation in lathe with accuracy of ± 0.5 mm (10 hrs.) 53. Perform Drilling & boring of blind hole with an accuracy of ± 0.3 mm (15 hrs.)	Lathe operations-facing, turning, parting-off,grooving, chamfering, boring etc. Knurling-types, grade & its necessity.
19	Set different components of machine & parameters to produce taper/ angular components and ensure proper assembly of the components. *[Different component of machine: Form tool, Compound slide, tail stock offset; Different machine*	54. Make taper turning by form tool with an accuracy of 1 degree. (05 hrs.) 55. Make taper turning by compound slide swivelling with an accuracy of ± 30 minute (20 hrs.)	Taper – different methods of expressing tapers, different standard tapers. Method of taper turning, important dimensions of taper. Taper turning by swiveling compound slide, its calculation.

	parameters- Feed, speed, depth of cut.]		
20	-do-	56. Make taper by off-setting tailstock with an accuracy of ± 30 minute. (20 hrs.) 57. Checking taper by Vernier Bevel Protractor and sine bar & slip gauge. (05 hrs.)	Calculations of taper turning by off-setting tail stock. Sine Bar – description & uses. Slip gauge –description and uses.
21&22	Set the different machining parameters to produce metric-v threaded components applying method/ technique and test for proper assembly of the components.	58. Cutting V thread (external) in a lathe and check with Screw Pitch Gauge. (22 hrs.) 59. Cutting V thread (internal) in a lathe and check with Screw Pith Gauge. (25 hrs.) 60. Fitting of male & female threaded components. (03 hrs.)	Different thread forms, their related dimensions and calculations of screw cutting in a lathe (Metric thread on English lathe and English thread on Metric lathe). Measurement of threads by three wire methods. Use of Screw Pitch Gauge.
23-26	**Revision**		
27	Set the different machining parameters and cutting tool to prepare job by performing different slotting operation. *[Different machining parameters – feed, speed and depth of cut. Different slotting operations –concave & convex surface, internal key ways, profiling, making internal sprocket with an accuracy of +/- 0.04 mm]*	61. Identification of slotting machine parts & its construction, use of rotary table. (10 hrs.) 62. Practice on slotting key ways on pulley with accuracy +/- 0.04 mm (15 hrs.)	Slotter– Classification, principle, construction, Safety precaution. Introduction and their indexing process on a Slotter by its Rotary table graduations. Driving mechanisms, quick return motion and speed ratio. Safety points to be observed while working on a Slotter.

28	-do-	63. Slotting a double ended spanner with accuracy +/- 0.1 mm. (25 hrs.)	Job holding devices-vice, clamps, V-block, parallel block etc. Slotting tools- types, tool angles.
29	-do-	64. Cutting sprocket teeth on slotting machine with accuracy +/- 0.04 mm. (25 hrs.)	Use of tool with holder for internal operations. Precautions to be observed during slotting internal operations. Use of circular marks on the table for slotting curves. Chain, Sprocket and their applications.
30	-do-	65. Cutting internal spline on slotting machine with accuracy +/-0.04 mm. (25 hrs.)	Spline – types and uses. **Coolant & lubricant –** Introduction, types, properties, application & applying methods.
31	Set the different machining parameters and cutters to prepare job by performing different milling operation and indexing. [Different machining parameters – feed, speed and depth of cut. Different milling operations – plain, face, angular, form, gang, straddle milling]	66. Identification of milling machine. (02 hrs.) 67. Demonstrate working principle of Milling Machine. (04 hrs.) 68. Set vice & job on the table of Milling Machine. (05 hrs.) 69. Set arbor on the spindle of milling machine. (08 hrs.) 70. Set the cutter on arbour. (04 hrs.) 71. Safety points to be observed while working on a milling machine. (02 hrs.)	Milling Machine: Introduction, types, parts, construction and specification. Driving and feed mechanism of Milling Machine.
32	-do-	72. Demonstrate Up Milling and Down Milling Process.(05hrs.) 73. Sequence of milling six faces of a solid block. (08 hrs.) 74. Check the accuracy with the help of try-square and vernier height gauge. (02hrs.)	Different types of milling cutters & their use. Cutter nomenclature.

		75. Perform Step milling using side and face cutter checking with depth micrometer. (05hrs.) 76. Perform slot milling using side and face cutter. (05hrs.)	
33	-do-	77. Make "V" Block using Horizontal Milling Machine with accuracy +/- 0.02 mm. (25 hrs.)	Different milling operations - plain, face, angular, form, slot, gang and straddle milling etc. Up and down milling.
34	-do-	78. Make concave surfaces with an accuracy +/-0.02 mm. (04 hrs.) 79. Make convex surfaces with an accuracy +/-0.02 mm. (04 hrs.) 80. Straddle milling operation with an accuracy +/-0.02 mm. (07 hrs.) 81. Gang milling operation with an accuracy +/-0.02 mm. (10 hrs.)	Different types of milling attachments and their uses.
35	-do-	82. Make Dovetail fitting (male & female) on Milling Machine with an accuracy +/-0.02 mm. (25 hrs.)	**Jigs and Fixtures–** Introduction, principle, types, use, advantages & disadvantages.
36	-do-	83. Make T-Slot fitting (male & female) on Milling Machine with an accuracy +/-0.02 mm. (25 hrs.)	Properties of metals general idea of physical, mechanical properties of metals, colour, weight, hardness toughness, malleability, ductility their effect on machinability. Heat Treatment – Introduction, necessity, types, Purposes, different methods of Heat Treatment. Heat Treatment of Plain Carbon Steel.
37	-do-	84. Demonstrate indexing head. (05 hrs.) 85. Set and align indexing head with reference to job on milling machine.(05 hrs.) 86. Make square job by direct/ simple	Indexing-introduction & types. Indexing head-types &constructional details, function of indexing plates and the sector arms.

		indexing method with an accuracy +/-0.02 mm. (06 hrs.) 87. Make hexagonal job by simple indexing method with an accuracy +/-0.02 mm. (09 hrs.)	Calculation for various types of indexing.
38	Set the different machining parameters to produce square & "V'' threaded components applying method/ technique and test for proper assembly of the components.	88. Checking of alignment of lathe centres and their adjustments. (03 hrs.) 89. Turning practice-between centres on mandrel (gear blank) with an accuracy +/-30 minute.(07 hrs.) 90. Taper turning by swivelling the cross slide.	Turning of taper by taper turning attachment - advantages and dis-advantages, taper calculations. Mandrel, Lathe centres, Lathe dog, catch plate/Driving plate, Face plate, Rests, their types & uses.
39-40	-do-	91. Make square thread (external) on a lathe with an accuracy +/-0.02 mm. (20 hrs.) 92. Make square thread (internal) on a lathe with an accuracy +/-0.02 mm. (22 hrs.) 93. Check with thread gauge – grinding of tool & setting in correct position. (05 hrs.) 94. Fitting of male & Female Square threaded components. (03 hrs.)	Terms relating screw thread major/ minor diameter, pitch and lead of the screw, depth of thread. Simple gear train and compound gear train change gears for fractional pitches. Square thread and its form and calculation of depth, core dia, pitch dia.
41	-do-	95. Make multi-start V thread on lathe with Screw Pitch gauge.(17 hrs.) 96. Perform eccentric turning with an accuracy +/-0.02mm. (08 hrs.)	Difference between single and multi-start threads- their uses, merits and demerits.
42	Produce components of high accuracy by different operations using grinding. [*Different operations – surface grinding, cylindrical grinding with an accuracy of+/- 0.01 mm*]	97. Identification of different types of grinding machine. (02 hrs.) 98. Wheel balancing & truing. (06 hrs.) 99. Dressing of grinding wheel. (02 hrs.) 100. Grinding of block (six sides) by surface grinding machine with an accuracy of +/- 0.01 mm. (15 hrs.)	**Grinding –** Introduction, grinding wheel-abrasive, types, bond, grade, grid, structure, standard marking system of grinding wheel, selection of the grinding wheel.

43	-do-	101. Grinding of step block by surface grinding machine with an accuracy of +/- 0.01 mm. (15 hrs..) 102. Grinding of slot block by surface grinding machine with an accuracy of +/- 0.01 mm. (10 hrs.)	Dressing, types of dresser. Glazing and Loading of wheels – its causes and remedies. Roughness values and their symbols. Explain the importance and necessity of quality.
44	-do-	103. *Set and perform angular grinding using universal vice/ sign vice to standard angle.*(05 hrs.) 104. *Make slide fit with an accuracy ± 0.01mm (male female)* (05hrs.) 105. *Perform form grinding* (05 hrs.) 106. *Make dovetail fitting with an accuracy ± 0.01mm (male & female)* (10 hrs.)	**Surface Grinder –** Types, Parts, construction, use, methods of surface grinding, specification & safety.
45	-do-	*Cylindrical grinding:* 107. *External Parallel cylindrical grinding (Both holding in chuck/ collet and in between centers. (15hrs.)* 108. *Plunge grinding (10hrs.)*	**Cylindrical grinder:** Introduction, parts, construction, types, specification, safety, different methods of cylindrical grinding.
46	-do-	109. Perform straight bore grinding (05hrs.) 110. Perform step bore grinding (05hrs.) 111. Internal taper bore grinding (05hrs.) 112. Make male female fitting with an accuracy of +/- 0.01 mm (10 hrs.)	Cutting speed, feed, depth of cut, machining time calculation.
47	-do-	113. External step cylindrical grinding with an accuracy of +/- 0.01 mm (15 hrs.) 114. External taper Cylindrical grinding with an accuracy of +/- 0.01 mm. (10 hrs.)	Wet grinding and dry grinding, various types of grinding wheels and their application, grinding defects and remedies.
48-49	**In-plant training/ Project work** **Broad area:** a) Drill extension socket		

	b) V-belt pulley c) Tail Stock Centre (MT – 3) d) Taper ring gauge e) Taper plug gauge. (Morse taper – 3)
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 project and also inputs from local industry may be taken for designing such new project.*
3. *The project should broadly covered 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 Project report.*
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.*
5. *More emphasis to be given on video/real-life pictures during theoretical classes. Some real-life pictures/videos of both conventional & CNC turning operation, production of different components, turning of complex job, etc., may be shown to the trainees to give a feel of Industry and their future assignment.*

SYLLABUS - MACHINIST			
Second Year			
Week No.	**Reference Learning Outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
53	Re-sharpen different single & multipoint cutting tool. [Different single point tools, slab milling cutter, side & face milling cutter, end mill cutter and shell end mill cutter.]	115. Demonstrate and practice of grinding of different single point tools. (25 hrs.)	**Tool & cutter grinder-** Introduction, parts, construction, use and specification, different types of tool rest & their application.
54	-do-	116. Demonstrate and practice of grinding of slab milling cutter. (13 hrs.) 117. Re-sharpening side and face milling cutter. (12 hrs.)	Various methods of cutter grinding.
55	-do-	118. Demonstrate and practice of grinding of end mill cutter. (10 hrs.) 119. Re-sharpening of shell end mill cutter. (15 hrs.)	Various cutter grinding attachments and their uses.
56	Set different machining parameters and cutters to prepare job by different milling machine operations. *[Different machining parameters - feed, speed, depth of cut, different machining operation – facing, drilling, tapping,*	120. Practice of facing on milling Machine. (10 hrs.) 121. Drill on P.C.D on milling Machine with accuracy +/-0.02 mm. (15 hrs.)	Geometrical tolerances, definition, symbol and their application. Depth Micrometer – Parts, reading, uses and safety.

	reaming, counter boring, counter sinking, spot facing, and boring slot cutting.]		
57	-do-	122. Perform Tapping and Reaming operation using milling Machine with an accuracy +/-0.02 mm.(10hrs.) 123. Perform spot facing operation using milling machine with accuracy +/-0.02 mm. (15 hrs.)	Different types of micrometers and their uses. Inside Micrometer – its parts, reading and uses. Bore Dial Gauge – its parts, reading (both in Metric and English system) and uses. Telescopic gauge.
58	-do-	124. Make slot on face of the job using milling Machine with an accuracy +/-0.02 mm. (10 hrs.) 125. Make Internal Grooving using milling Machine with an accuracy 0.02 mm. (15 hrs.)	Gauges – different types and their uses, difference between Gauges and Measuring Instruments. Gear introduction, use and type. Elements of a spur gear.Gear tooth of each forms types, merits and demerits of each.
59	Set the different machining parameters and cutters to prepare components by performing different milling operation and indexing. *[Different machining parameters – feed, speed and depth of cut. Different components – Rack, Spur Gear, External Spline, Steel Rule, Clutch, Helical Gear]*	126. Make Straight Teeth Rack using Milling Machine with an accuracy 0.05 mm. (10 hrs.) 127. Make Helical Teeth Rack using Milling Machine with an accuracy 0.05 mm one straight rack (10 hrs.) 128. Measurement of teeth by Vernier Gear Tooth Caliper. (05 hrs.)	Rack – types, uses and calculations. Selection of gear cutter type and form & various methods of checking gear and its parts. Vernier gear tooth caliper - its construction and application in checking gear tooth.
60	-do-	129. Make spur gear using Simpleindexing with an accuracy 0.05 mm. (10 hrs.) 130. Make spur gear using differential	Spur gear calculations, curves and their uses. Use of radius gauges and template.

		indexing with an accuracy 0.05 mm. (15 hrs.)	
61	-do-	131. Perform Boring operation on Vertical Milling Machine with an accuracy 0.05 mm. (25 hrs.)	Vertical Milling Machine- its parts. Method of boring in Vertical milling. Difference between Horizontal and Vertical Milling Machine.
62	-do-	132. Make helical gear on milling machine with an accuracy 0.05 mm. (25 hrs.)	Helix and Spiral introduction, types and elements. Difference between helix & spiral. Difference between R.H. and L.H. helix. Helical gear- elements, application. Calculations for cutting helical gear.
63	-do-	133. Make straight flute milling on Milling Machine with an accuracy 0.05 mm. (12 hrs.) 134. Make helical flute on Milling Machine with an accuracy 0.02 mm. (13 hrs.)	Reamer – types, elements and uses. Calculations for cutting Reamer. Twist drill-nomenclature, cutter selection. Calculations for cutting twist drill.
64-65	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.*]	135. Measure Current, Voltage and Resistance using Simple Ohm`s Law Circuit And Familiarizing Multi-meter. (05hrs.) 136. Soldering Techniques (05hrs.) 137. Step up and step down transformers. (05hrs.) 138. Working with Solenoids and Relays. (05hrs.) 139. Working of Motor & Generators. (05hrs.) 140. Behaviour of Proximity Sensors. (05hrs.) 141. Behaviour of ultrasonic sensors. (05hrs.) 142. Logical Operation of Sensors. (05hrs.) 143. Limit & Level Control using Sensors. (05hrs.) 144. Interfacing of Sensors with Electrical Actuators. (05hrs.)	Study of basic Electricals- Voltage – Current etc. Working Of Solenoids, Inductors, Motors, Generator Based On Electromagnetic Induction Principle Switches, Fuse And Circuit Breakers Introduction To Sensors- Fundamental Of Sensor Proximity Sensors Classification And Operation-Proximity Sensor-Types Of Proximity Sensor And Their Working-Industrial Application Sensors For Distance And Displacement - LVDT-Linear Potentiometer-Ultrasonic And Optical Sensors-Industrial Application.
66	Set (both job and tool) CNC turning centre and produce components as per	145. Know rules of personal and CNC machine safety, safe handling of tools,safety switches and material handling equipment	Personal safety, safe material handling, and safe machine operation on CNC turning centers.

	drawing by preparing part programme	using CNC didactic/ simulation software and equipment. (03 hrs.) 146. Identify CNC lathe machine elements and their functions, on the machine. (07 hrs.) 147. Understand the working of parts of CNC lathe, explained using CNC didactic/ simulation software. (09 hrs.) 148. Identify machine over travel limits and emergency stop, on the machine. (01 hr) 149. Decide tool path for turning, facing, grooving, threading, drilling. (04hrs.) 150. Identification of safety switches and interlocking of DIH modes. (01 hr)	CNC technology basics, Comparison between CNC and conventional lathes. Concepts of positioning accuracy, repeatability. CNC lathe machine elements and their functions - bed, chuck, tailstock, turret, ball screws, guide ways, LM guides, coolant system, hydraulic system, chip conveyor, steady rest, console, spindle motor and drive, axes motors, tail stock, encoders, control switches. Feedback, CNC interpolation, open and close loop control systems. Machining operations and the tool paths in them – stock removal in turning and facing, grooving, face grooving, threading, drilling.
67-68	-do-	151. Identify common tool holder and insert shapes by ISO nomenclature. (05hrs.) 152. Select cutting tool and insert for each operation. (03hrs.) 153. Fix inserts and tools in tool holders. (02hrs.) 154. Decide cutting tool material for various applications. (03hrs.) 155. Select cutting parameters from tool manufacturer's catalogue. (02hrs.) 156. Write CNC programs for simple tool motions and parts using linear and circular interpolation, check on program verification/ simulation software. (10hrs.) 157. Write CNC part programs using canned cycles for stock removal, grooving, threading operations, with drilling and finish turning. Use TNRC commands for finish turning. Check simulation on program verification/ simulation software. (20hrs.)	Concept of Co-ordinate geometry, concept of machine coordinate axis, axes convention on CNC lathes, work zero, machine zero. Converting part diameters and lengths into co-ordinate system points. Absolute and incremental programming. Programming – sequence, formats, different codes and words. ISO G codes and M codes for CNC turning. Describe CNC interpolation, open and close loop control systems. Co-ordinate systems and Points. Program execution in different modes like MDI, single block and auto. Canned cycles for stock removal (turning/facing), grooving, threading, for external and internal operations.

		158. Avoiding collisions caused by program errors. Knowing causes and effects of collisions due to program errors, by making deliberate program errors and simulation on program verification/ simulation software. (05 hrs.)	Tool nose radius compensation (TNRC) and why it is necessary. Find the geometry page in CNC machine. Cutting tool materials, application of various materials. Cutting tool geometry for internal and external turning, grooving, threading, face grooving, drilling. Insert holding methods for each. Insert cutting edge geometry. ISO nomenclature for turning tool holders, boring tool holders, Indexable inserts. Cutting parameters- cutting speed, feed rate, depth of cut, constant surface speed, limiting spindle speed. Tool wear, tool life, relative effect of each cutting parameter on tool life. Selection of cutting parameters from a tool manufacturer's catalogue for various operations. Writing part programs as per drawing & checking using CNC program verification/ simulation software. Process planning, work holding, tool and cutting parameters selection according to the part geometry and dimensions. Collisions due to program errors, effects of collisions. Costs associated with collisions – tool breakage, machine damage, injuries.
69-70	-do-	159. Conduct a preliminary check of the readiness of the CNC lathe - cleanliness of machine, functioning of lubrication, coolant level, correct working of	Program execution in different modes like MDI, single block and auto. Process planning & sequencing, tool layout& selection and cutting

		sub-systems,on the machine. (05 hrs.) 160. Starting the machine, do homing on CNC simulator. (02 hrs.) 161. Entering the CNC program in EDIT mode for an exercise on Simple turning & Facing (step turning) without using canned cycles, on CNC simulator. (15 hrs.) 162. Mounting jaws to suit the part holding area on CNC machine (03hrs.) 163. Mounting tools on the turret according to part and process requirement, on CNC simulator &on CNC machine. (08hrs.) 164. Perform Work and tool setting: Job zero/work coordinate system and tool setup and live tool setup. (08hrs.) 165. Determining work and tool offsets using JOG, MDI, MPG modes, on CNC simulator. (08hrs.) 166. Entering the tool offsets, tool nose radii and orientation for TNRC in offsets page, on CNC simulator. (05hrs.)	parameters selection. Work and tool offsets. Inputs value to the offset/ geometry page into machine. Turning in multiple setups, hard and soft jaws, soft jaw boring, use of tailstock and steady rest. Length to diameter (L/D) ratio and deciding work holding based on it. Machine operation modes – Jog, MDI, MPG, Edit, Memory. Entering and editing programs on machine console, entering offsets data in offsets page. Use of Emergency stop, Reset, Feed rate override, spindle speed override, edits lock on/off buttons and keys.
71-73	-do-	167. Program checking in dry run, single block modes, on CNC simulator & CNC machine. (01hr) 168. Absolute and incremental programming assignments and simulation. (04 hrs.) 169. Checking finish size by over sizing through tool offsets, on CNC simulator. (02hrs.) 170. Prepare part program and cut the part in auto mode in CNC machine for the exercise on Simple turning & Facing (step turning) (08 hrs.) 171. Recovering from axes over travel, on CNC simulator (01 hr)	First part checking: Program checking in single block and dry run modes – necessity and method. Tool offsets adjustment on first part for close tolerance dimensions, by over sizing (for outside dimensions) or under sizing (for inside dimensions) the dimension to prevent part rejection. Wear offset setting – necessity, relationship with tool wear, entering in offsets page. Process and tool selection related to grooving, drilling, boring and threading. Axes over travel, recovering from over travel. Collisions due to improper machine

		172. Part program writing, setup, checking and Automatic Mode Execution for exercise on Turning with Radius/ chamfer with TNRC on CNC machine (10hrs.) 173. Part program writing, setup, checking and Automatic Mode Execution for exercise on Turning with TNRC, grooving and threading, on CNC simulator & on CNC machine (12hrs.) 174. Checking finish size by over sizing through tool offsets, on the machine. (02 hrs.) 175. Machining parts on CNC lathe with combination step, taper, radius turning, grooving &threading, with external and internal operations, first and second operation, on the machine. (10 hrs.) 176. Machining long part on CNC lathe held in chuck and tailstock (between centers). (04 hrs.) 177. Starting from interruption due to power shutdown, tool breakage. (01hr) 178. Changing wear offsets to take into account tool wear. (02hrs.) 179. Part program preparation, Simulation & Automatic Mode Execution of CNC Machine for the exercise on Blue print programming contours with TNRC. (08 hrs.) 180. Carryout Drilling/Boring cycles in CNC Turning. (10 hrs.) *(First 60% of the practice is on CNC machine simulator, followed by 40% on machine.)*	setup and operation – causes and effects. Recovering from collisions. Find out alarm codes and meaning of those codes.

74-75	**Implant training/ Project work: -** **Broad area:** a) Pedestal bearing b) Crank shaft c) Arbor with clamping nut d) Threaded mandrel e) Quick change tool post		
76-78	**Revision**		
79-80	Set CNC VMC (vertical machining center) and produce components as per drawing by preparing part program	181. Know rules of personal and CNC machine safety, safe handling of tools and material handling equipment. Using CNC didactic/ simulation software and equipment. (02 hrs.) 182. Identify CNC vertical machining center machine elements and their functions, on the machine. (20 hrs.) 183. Understand working of parts of CNC VMC, explained using CNC didactic/ simulation software (20 hrs.) 184. Identify machine over travel limits and emergency stop, on the machine. (05hrs.) 185. Decide tool path for Face milling, Side milling, Pocket milling, Drilling, Countersinking, tapping, Reaming, Rough boring, Finish boring, Spot facing. (03hrs.)	Safety aspects related to CNC VMC. CNC technology basics, Comparison between CNC VMC and conventional milling machines. Concepts of positioning accuracy, repeatability. CNC VMC machine elements and their functions - bed, chuck, Auto tool changer (ATC), ball screws, guide ways, LM guides, coolant system, hydraulic system, chip conveyor, rotary table, pallet changer, console, spindle motor and drive, axes motors, encoders, control switches. Feedback, CNC interpolation, open and close loop control systems. Machining operations and the tool paths in them - Face milling, Side milling, Pocket milling, Drilling, Countersinking, Rigid tapping, floating tapping Reaming, Rough boring, Finish boring, Spot facing.
81-82	-do-	186. Identify common tools, tool holders and inserts. (03hrs.) 187. Select cutting tool, insert and holder for each operation. (03hrs.) 188. Fix inserts and tools in tool holders. (01hr) 189. Decide cutting tool material for various applications. (02hrs.) 190. Select cutting parameters from tool manufacturer's catalog. (01 hr)	Concept of Co-ordinate geometry& polar coordinate points, concept of machine axis, axes convention on CNC lathes, work zero, machine zero. Converting part dimensions into co-ordinate system points. Absolute and incremental programming. Programming - sequence, formats, different codes and words. ISO G and M codes for CNC milling.

		191. Write CNC programs for simple parts using linear and circular interpolation, absolute and incremental modes, checkon program verification software. (10 hrs.) 192. Write CNC part programs for parts with face milling, pocket milling with subprograms. Check on program verification software. (10hrs.) 193. Write CNC part programs for pocket milling, drilling with canned cycle, countersinking with canned cycle, tapping with canned cycle. Check on program verification software. (15hrs.) 194. Avoiding collisions caused by program errors. Knowing causes and effects of collisions due to program errors, by making deliberate program errors and simulation on program verification software. (05 hrs.)	Canned cycles for drilling, peck drilling, reaming, tapping, finish boring. Subprograms. Cutter radius compensation (CRC)and why it is necessary. Cutting tool materials, application of various materials. Cutting tool geometry for face mill, end mill, drill, countersink, tap, finish bore, reamer. Insert holding methods face mill, insert type end mill and insert type drill. Insert cutting edge geometry. Cutting parameters- cutting speed, feed rate, depth of cut. Tool wear, tool life, relative effect of each cutting parameter on tool life. Selection of cutting parameters from a tool manufacturer's catalog for various operations. Writing part programs as per drawing & check using CNC program verification software. Process planning, work holding, tool and cutting parameters selection according to the part geometry and dimensions. Collisions due to program errors, effects of collisions. Costs associated with collisions - tool breakage, machine damage, injuries.
83-84	-do-	195. Conduct a preliminary check of the readiness of the CNC VMC - cleanliness of machine, functioning of lubrication, coolant level, correct working of sub-systems. On the machine. (03 hrs.) 196. Starting the machine, do homing on CNC simulator. (03 hrs.) 197. Entering the CNC program in EDIT mode for an exercise on	Program execution in different modes like manual, single block and auto. Process planning & sequencing, tool layout & selection and cutting parameters selection. Work offset, tool length offset, tool radius offset. Work holding with temporary holding and fixtures. Truing of part and fixture.

		face milling and drilling without using canned cycles, on CNC simulator. (20 hrs.) 198. Mounting tools on the ATC according to part and process requirement, on CNCsimulator& CNC machine. (08hrs.) 199. Determining work and tool offsets using JOG, MDI, MPG modes, on CNC simulator& CNC machine. (07hrs.) 200. Tool change in CNC milling and JOG, MDI, MPG mode operation. (06 hrs.) 201. Entering the work offset, tool length offsets, tool radii and, on CNC simulator. (03hrs.)	Machine operation modes - Jog, MDI, MPG, Edit, Memory. Entering and editing programs on machine console, entering offsets data in offsets page. Use of Emergency stop, Reset, Feed rate override, spindle speed override, edit lock on/off buttons and keys.
85-86	-do-	202. Program checking in dry run, single block modes, on CNC simulator. (02hrs.) 203. Checking finish size by over or under sizing through tool offsets, on CNC simulator.(03hrs.) 204. Prepare part programme, enter, edit and simulate. (03 hrs.) 205. Carryout tool path simulation. (02hrs.) 206. Recovering from axes overtravel, on virtual machine simulator (02hrs.) 207. Part program writing, setup, checking and Automatic Mode Execution for exercise on side milling with CRC, on CNC simulator & CNC machine. (10hrs.) 208. Part program writing, setup, checking and Automatic Mode Execution for exercise on face milling, drilling, countersinking, tapping using canned cycle, on CNC simulator & CNC machine (15 hrs.) 209. Automatic mode execution of CNC	First part checking: Program checking in single block and dry run modes - necessity and method. Tool offsets adjustment on first part for close tolerance dimensions, by oversizing (for outside dimensions) or under sizing (for inside dimensions) the dimension to prevent part rejection. Axes overtravel, recovering from overtravel. Collisions due to improper machine setup and operation - causes and effects. Recovering from collisions. State the importance of Helical inter-polar and thread milling, advantage and limitation in CNC machine.

		Machine Exercises with Block Search and restart. (08 hrs.) 210. Mounting clamps, locators, supports, truing part and fixture. (05hrs.)	
87-89	-do-	211. Machining part on CNC VMC with face milling, drilling. (05 hrs.) 212. Machining parts on CNC VMC with combination face milling, side milling with CRC, drilling, countersinking, tapping. Use canned cycles and subprograms wherever possible. (05 hrs.) 213. Machining of part with closely controlled slot dimension usingCRC. (05hrs.) 214. Machining of part with pockets. (02 hrs.) 215. End milling with polar co-ordinates. (04 hrs.) 216. Part programs & Simulation Automatic Mode Execution of CNC Machine for the exercise on End milling with polar co-ordinates and practical on Simple drilling-G 81. (06 hrs.) 217. Determining and entering wear offsets. (03 hrs.) 218. Restarting machine from power shutdown or sudden stoppage. (01hr) 219. Program transfer to machine through electronic media - USB and flash drive. (01 hr) 220. Merging the work zero with program zero point, geometry and wear offset correction. (02 hrs.) 221. Practical on Chamfer and counter-sink drilling. (02 hrs.) 222. Carryout Deep hole drilling G 83. (03 hrs.) 223. Perform Threading and tapping G 84. (06 hrs.) 224. Carryout Boring cycles G 85 - G 89.	Tool wear and necessity for wear offsets change, entering wear offsets in offsets page. Effects of sudden machine stoppage due to power shutdown or use of emergency stop. Restarting machine from sudden stoppage. Means of program transfer through electronic media. Productivity concepts, cycle time, machine down time, causes of down time - breaks, machine breakdown, inspection, part loading and unloading, chip cleaning. Effect of down time on profitability, reducing down time. Machine hour rate, components of machine hour rate - principal repayment, interest, overheads (power, tooling, space, salaries, indirect expenses). Calculation of machining cost, cost of down time.

		(08 hrs.) 225. Preparations of part programs for thread cutting/thread milling for CNC machining centres.(06 hrs.) 226. Drilling milling patterns, Thread milling etc. (03 hrs.) 227. Circular and rectangular pockets machining. (03 hrs.) 228. Calculation of machine hour ratesfor typical CNC lathe and VMC.(05 hrs.) 229. Estimation of cycle time for parts with face milling, side milling, drilling, tapping operations. (05hrs.) *(First 60% of the practice is on CNC machine simulator, followed by 40% on machine.)*	
90	-do-	230. Prepare different types of documentation as per industrial need by different methods of recording information. (25 hrs.)	Machine productivity concepts – cycle time, down time, cycle time estimation. Costing - machine hour rate, machining cost, tool cost, cost of down time. Importance of Technical English terms used in industry. Technical forms, process sheet, activity log, job card, in industry-standard formats.
91	Plan and perform simple repair, overhauling of different machines and check for functionality. *[Different Machines - Drilling Machine, milling machine and Lathe]*	231. Perform Periodic Lubrication system on Machines. (10 hrs.) 232. Perform simple repair work.(15hrs.)	Lubricating system-types and importance
92	-do-	233. Perform the routine maintenance with check list. (05hrs.) 234. Inspection of Machine tools such as alignment, leveling etc. (10 hrs.) 235. Accuracy testing of machine tools such as geometrical	Maintenance: Definition, types and its necessity. System of symbol and colour coding. Possible causes for failure and remedies.

		parameters.(10 hrs.)	
93	Set the different machining parameters and cutters to prepare components by performing different milling operation and indexing. *[Different machining parameters - feed, speed and depth of cut. Different components - end mill, bevel gear, cam, worm & worm wheel]*	236. Cutting teeth on helical slab/ cylindrical cutter and end mill cutter with an accuracy of +/-0.05 mm. (25 hrs.)	Calculations for cutting helical slab/ cylindrical cutter.Calculations for cutting End Mill cutter.
94	-do-	237. Cutting bevel gears on a milling machine with an accuracy of +/- 0.05 mm. (25 hrs.)	Bevel gear-elements, types, application, calculation for cutting bevel gear.
95	-do-	238. Cutting a plate cam with angular setting in milling machine with an accuracy of +/-0.05 mm. (25 hrs.)	Cam-types, elements & application, Plate cam-manufacturing & calculations. Drum cam- its calculation,advantages, types of follower & its purposes,
96	-do-	239. Cutting worm wheel on a milling machine with an accuracy of +/- 0.05 mm. (25 hrs.)	Worm wheel-application, elements & calculation, Worm-calculation.
97	-do-	240. Cutting worm thread on a milling machine with an accuracy of +/- 0.05 mm. (25 hrs.)	Types of Keys and their uses. Variation - types and causes. Testing of Gear and error.
98-101	**In-plant training/ Project work** (Any Project to be done involving CNC machine also) **Broad area:** a) Socket With Split Collet b) Screw Jack c) Crank Shaft With Taper Sleeve d) Crank and slotted link mechanism e) Stub arbor with collet and nuts f) Compound gear train		
102-103	**Revision**		
104	**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 project and also inputs from local industry may be taken for designing such new project.*
3. *The project should broadly covered 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 Project report.*
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*
5. *More emphasis to be given on video/real-life pictures during theoretical classes. Some real-life pictures/videos of both conventional & CNC turning operation, production of different components, turning of complex job, etc., may be shown to the trainees to give a feel of Industry and their future assignment.*

9. SYLLABUS - CORE SKILLS

9.1 Workshop Calculation Science & Engineering Drawing:

S No.	Workshop Calculation and Science	Engineering Drawing
First Year		
1.	**Unit**: Systems of unit- FPS, CGS, MKS/SI unit, unit of length, Mass and time, Conversion of units	Engineering Drawing: Introduction and its importance - Relationship to other technical drawing types - Conventions - Viewing of engineering drawing sheets - Method of Folding of printed Drawing Sheet as per BIS SP:46-2003
2.	**Fractions**: Fractions, Decimal fraction, L.C.M., H.C.F., Multiplication and Division of Fractions and Decimals, conversion of Fraction to Decimal and vice versa. Simple problems using Scientific Calculator.	Drawing Instruments: their Standard and uses - Drawing board, T-Square, Drafter (Drafting M/c), Set Squares, Protractor, Drawing Instrument Box (Compass, Dividers, Scale, Diagonal Scales etc.), Pencils of different Grades, Drawing pins/ Clips.
3.	**Square Root**: Square and Square Root, method of finding out square roots, Simple problem using calculator.	Lines: - Definition, types and applications in Drawing as per BIS SP:46-2003 - Classification of lines (Hidden, centre, construction, Extension, Dimension, Section) - Drawing lines of given length (Straight, curved) - Drawing of parallel lines, perpendicular line - Methods of Division of line segment
4.	**Ratio &Proportion**: Simple calculation on related problems.	Drawing of Geometrical Figures: Definition, nomenclature and practice of - Angle: Measurement and its types, method of bisecting. - Triangle-different types - Rectangle, Square, Rhombus, Parallelogram. - Circle and its elements.

5.	**Percentage**: Introduction, Simple calculation. Changing percentage to decimal and fraction and vice-versa.	Lettering and Numbering as per BIS SP46-2003: - Single Stroke, Double Stroke, inclined, Upper case and Lower case.
6.	**Material Science**: Properties- Physical & Mechanical, Types–Ferrous & Non-Ferrous, difference between Ferrous and Non-Ferrous metals, introduction of Iron, Cast Iron, Wrought Iron, Steel, difference between Iron and Steel, Alloy steel, carbon steel, stainless steel, Non-Ferrous metals, Non-Ferrous Alloys.	Dimensioning: - Definition, types and methods of dimensioning (functional, non-functional and auxiliary) - Types of arrowhead - Leader Line with text
7.	**Mass, Weight and Density**: Mass, Unit of Mass, Weight, difference between mass and weight, Density, unit of density, specific gravity of metals.	Free hand drawing of - Lines, polygons, ellipse, etc. - geometrical figures and blocks with dimension - Transferring measurement from the given object to the free hand sketches.
8.	**Speed and Velocity**: Rest and motion, speed, velocity, difference between speed and velocity, acceleration, retardation, equations of motions, simple related problems.	Sizes and Layout of Drawing Sheets - Basic principle of Sheet Size - Designation of sizes - Selection of sizes - Title Block, its position and content - Borders and Frames (Orientation marks and graduations) - Grid Reference - Item Reference on Drawing Sheet (Item List)
9.	**Work, Power and Energy**: work, unit of work, power, unit of power, Horse power of engines, mechanical efficiency, energy, use of energy, potential and kinetic energy, examples of potential energy and kinetic energy.	Method of presentation of Engineering Drawing - Pictorial View - Orthogonal View - Isometric view
10.	-----	Symbolic Representation (as per BIS SP:46-2003) of: - Fastener (Rivets, Bolts and Nuts)

		- Bars and profile sections - Weld, brazed and soldered joints. - Electrical and electronics element - Piping joints and fittings
11.	**Algebra**: Addition, Subtraction, Multiplication, Division, Algebraic formula, Linear equations (with two variables).	Construction of Scales and diagonal scale
12.	**Mensuration:**Area and perimeter of square, rectangle, parallelogram, triangle, circle, semi-circle. Volume of solids – cube, cuboids, cylinder and Sphere. Surface area of solids – cube, cuboids, cylinder and Sphere.	Practice of Lettering and Title Block
13.	**Trigonometry:**Trigonometrical ratios, measurement of angles. Trigonometric tables	Dimensioning practice: - Position of dimensioning (unidirectional, aligned, oblique as per BIS SP:46-2003) - Symbols preceding the value of dimension and dimensional tolerance. - Text of dimension of repeated features, equidistance elements, circumferential objects.
14.	**Heat & Temperature**: Heat and temperature, their units, difference between heat and temperature, boiling point, melting point, scale of temperature, relation between different scale of temperature, Thermometer, pyrometer, transmission of heat, conduction, convection, radiation.	Construction of Geometrical Drawing Figures: - Different Polygons and their values of included angles. Inscribed and circumscribed polygons. - Conic Sections (Ellipse& Parabola)
15.	**Basic Electricity**: Introduction, use of electricity, how electricity is produced, Types of current_ AC, DC, their comparison, voltage, resistance, their units. Conductor, insulator, Types of connections – series, parallel, electric	Drawing of Solid figures (Cube, Cuboids, Cone, Prism, Pyramid, Frustum of Cone and Pyramid.) with dimensions.

	power, Horse power, energy, unit of electrical energy.	
16.	**Levers and Simple Machines:**Levers and its types. Simple Machines, Effort and Load, Mechanical Advantage, Velocity Ratio, Efficiency of machine, Relationship between Efficiency, velocity ratio and Mechanical Advantage.	Free Hand sketch of hand tools and measuring tools used in respective trades.
17.	---	Projections: - Concept of axes plane and quadrant. - Orthographic projections - Method of first angle and third angle projections (definition and difference) - Symbol of 1st angle and 3rd angle projection as per IS specification.
18.	--	Drawing of Orthographic projection from isometric/3D view of blocks
19.	--	Orthographic Drawing of simple fastener (Rivet, Bolts, Nuts & Screw)
20.	--	Drawing details of two simple mating blocks and assembled view.

S No.	Workshop Calculation and Science	Engineering Drawing
Second Year		
1.	- Geometrical construction & theorem: division of line segment, parallel lines, similar angles, perpendicular lines, isosceles triangle and right angled triangle.	- Revision of first year topics.
2.	- Area of cut-out regular surfaces: circle and segment and sector of circle.	- Machined components; concept of fillet & chamfer; surface finish symbols.
3.	- Area of irregular surfaces. - Application related to shop problems.	- Screw thread, their standard forms as per BIS, external and internal thread, conventions on the features for drawing as per BIS.
4.	- Volume of cut-out solids: hollow cylinders, frustum of cone, block section. - Volume of simple machine blocks.	- Free hand Sketches for bolts, nuts, screws and other screwed members.
5.	- Material weight and cost problems related to trade.	- Standard rivet forms as per BIS (Six types).
6.	- Finding the value of unknown sides and angles of a triangle by trigonometrical method.	- Riveted joints-Butt & Lap (Drawing one for each type).
7.	- Finding height and distance by trigonometry.	- Orthogonal views of keys of different types
8.	- Application of trigonometry in shop problems. (viz. taper angle calculation).	- Free hand sketches for simple pipe, unions with simple pipe line drawings.
9.	- Forces definition. - Compressive, tensile, shear forces and simple problems. -Stress, strain, ultimate strength, factor of safety. -Basic study of stress-strain curve for MS.	- Concept of preparation of assembly drawing and detailing. Preparation of simple assemblies & their details of trade related tools/job/exercises with the dimensions from the given sample or models.
10.	- Temperature measuring instruments. Specific heats of solids & liquids.	-Free hand sketch of trade related components/ parts (viz., single tool post for the lathe, etc.)
11.	- Thermal Conductivity, Heat loss and heat gain.	- Study of assembled views of Vee-blocks with clamps.
12.	- Average Velocity, Acceleration & Retardation. - Related problems.	- Study of assembled views of shaft and pulley.
13.	- Circular Motion: Relation between circular motion and Linear motion, Centrifugal force, Centripetal force	- Study of assembled views of bush bearing.
14.	--	- Study of assembled views of a simple coupling.

15.	--	- Free hand sketching of different gear wheels and nomenclature.
16.	**Graph:** - Read images, graphs, diagrams -bar chart, pie chart. - Graphs: abscissa and ordinates, graphs of straight line, related to two sets of varying quantities.	- Free hand details and assembly of simple bench vice.
17.	Simple problem on Statistics: - Frequency distribution table - Calculation of Mean value. - Examples on mass scale productions. -Cumulative frequency -Arithmetic mean	- Reading of drawing. Simple exercises related to missing lines, dimensions. How to make queries.
18.	Acceptance of lot by sampling method (within specified limit size) with simple examples (not more than 20 samples).	- Simple exercises relating missing symbols. - Missing views
19.	- Friction- co-efficient of friction, application and effects of friction in Workshop practice. **Centre of gravity** and its practical application.	- Simple exercises related to missing section.
20.	- Magnetic substances- natural and artificial magnets. - Method of magnetization. Use of magnets.	-Free hand sketching of different types of bearings and its conventional representation.
	- Electrical insulating materials. - Basic concept of earthing.	- Solution of NCVT test. - Simple exercises related to trade related symbols. - Basic electrical and electronic symbols.
	- Transmission of power by belt, pulleys & gear drive. - Calculation of Transmission of power by belt pulley and gear drive.	- Study of drawing & estimation of materials.
	- Heat treatment and advantages.	- Solution of NCVT test papers.
	Concept of pressure – units of pressure, atmospheric pressure, absolute pressure, gauge pressure – gauges used for measuring pressure.	
	Introduction to pneumatics & hydraulics systems.	

9.2 EMPLOYABILITY SKILLS:

CORE SKILL – EMPLOYABILITY SKILL		
Duration: 110 Hours		
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 vitae 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 computer.	
Computer Operating System	Basics of Operating System, WINDOWS, 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 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, and 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 selected 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 House-keeping, practice of good housekeeping.
Quality Tools	Basic quality tools with a few examples.

ANNEXURE-I

LIST OF TOOLS AND EQUIPMENT			
MACHINIST (For batch of 20 Candidates)			
S No.	**Name of the Tool & Equipment**	**Specification**	**Quantity**
A. TRAINEES TOOL KIT			
1.	Steel rule	30 cm graduated both in English & Metric units	*21 nos.
2.	Outside spring caliper	150 mm	*15 nos.
3.	Inside spring caliper	150 mm	*15 nos.
4.	Hermaphrodite caliper	150 mm	*15 nos.
5.	Divider spring	150 mm	*15 nos.
6.	Centre Punch	100 mm	*15 nos.
7.	Hammer	B.P. 0.5 kg	*15 nos.
8.	Cold chisel flat	25 x 200 mm	*21 nos.
9.	File flat bastard	300 mm	*21 nos.
10.	File flat	2nd cut 250 mm	*21 nos.
11.	File flat smooth	200 mm	*21 nos.
12.	Screw Driver	10 X 200 mm	*21 nos.
13.	Combination Plier	150 mm	*15 nos.
14.	Safety glasses		*21 nos.
B. INSTRUMENTS AND GENERAL SHOP OUTFIT			
15.	Surface plate	400 mm x 400mm grade	1 no.
16.	Marking off table	1200 x 1200 x 600 mm high with stand	1 no.
17.	Scribing block universal	300 mm	2 nos.
18.	V- Block	100/7 – 80 – A	2 nos.
19.	Try square	300 mm	2 nos.
20.	Outside spring caliper	200 mm	2 nos.
21.	Divider spring	200 mm	2 nos.
22.	Inside spring caliper	200 mm	2 no.
23.	Straight edge steel	1 meter	1 no.
24.	Straight edge steel	500 mm	1 no.
25.	Steel tape	2 meter in case	1 no.
26.	Steel rule	60 cm graduated both in English & Metric units	2 nos.
27.	Sprit level	2V 250, 05 meter	1 no.
28.	Hammer	B.P. 800 gms with handle	*7 nos.

29.	Screw driver, heavy duty	300 mm with handle	*7 nos.
30.	Hammer lead	1 kg.	2 nos.
31.	Spindle blade screw driver	100 mm	*7 nos.
32.	Allen Hexagonal keys	2.5 to 12	2 sets
33.	Spanner D.E.	series 2 (set of 7 pieces)	*10 sets
34.	Adjustable spanner	300 mm	2 nos.
35.	Reduction sleeve Morse	1-1, 3-1, 4-1, 4-2, 5-1, 5-2, 6-1,	2 nos. each
36.	Angle plate size	200 x 100 x 200 mm	2 nos.
37.	Angle plate adjustable	250 x 150 x 175 mm	2 nos.
38.	Solid parallels in pairs (different sizes) in Metric		*20 pairs
39.	Oil Can pressure feed	500 mg	(assorted)
40.	Oil stone	150 x 50 x 25 mm	*10 nos.
41.	Number drills H.S.S. (parallel shank)		2 nos.
42.	Punch letter set.	3 mm	1 no.
43.	Punch number set	3 mm	1 no.
44.	Twist drills	3 mm to 13 mm in step of 0.5 mm (parallel shank)	1set
45.	Drill Chuck	0-13 mm with taper shank	2 set
46.	Centre drill	A 1 to 5	1 no.
47.	Grinding wheel dresser (diamond)		2 set
48.	Grinding wheel dresser Huntington type		1 no.
49.	Clamps C	100 mm	2 nos.
50.	Clamps C	200 mm	2 nos.
51.	Tap and Die set in box metric pitch	(6 mm to 12 mm)	2 nos.
52.	Drill H.S.S. taper shank	(6 mm to 12 mm in step of 0.5 mm)	1 set
53.	File Half round	2nd cut 250 mm	*7 nos.
54.	File triangular smooth	200 mm	*7 nos.
55.	Needle file set		*7 nos.
56.	File square	2nd cut 250 mm	1no.
57.	Reamer	6 mm to 25 mm by 1 mm	*7 nos.
58.	Reamer adjustable	10 mm to 15 mm length 75 mm	1 set
59.	Tool bits	H.S.S. 6 mm square	1 dozen
60.	Tool bits	H.S.S. 10 mm square	1 dozen
61.	Tool bits holder (Armstrong) L.H		1 dozen
62.	Tool bits holder (Armstrong) R.H.		*7 nos.

63.	Assorted tools and bit holders for lathe, shaper, slotter & planner in different shapes and sizes		4 nos. as required
64.	Hacksaw frame adjustable	250-300 mm with blades	2 nos.
65.	Table chuck	75 mm jaw swivel base	1 no.
66.	Bench vice	100 mm jaw	2 nos.
67.	Machine vice	200 mm swivel base	4 nos.
68.	Machine Vice	Swivel Base -150 mm	2 nos.
69.	Hand vice	50 mm jaw	2 nos.
70.	Radius turning attachment		1 no.
71.	Angle turning attachment		1 no.
72.	Compound angle vice (standard sine)		1 no.
73.	Universal Machine Vice	100 mm	1 no.
74.	Universal Table Angle Plate	150 X 150 X 150 mm	1 no.
75.	Shaper tool holder turret type to suit the machine		2 nos.
76.	Base chuck for slotter to suit the machine		1 no.
77.	Shaper indexing center to suit the machine		1 no.
78.	Knurling tools	(set of 3) straight and diamond	1 each
79.	Plier cutting	200 mm	2 nos.
80.	Carbide tipped tools of different sizes and shapes (throw away tips)		2 sets
81.	Hand hammer	1 kg With handle	2 nos.
Tool list for Electrical and Sensors: **i) Tool list for Electrical**			
82.	Digital Multimeter	0 to 500 V	2 nos.
83.	Variable Resistance Box	Resistors With 220Ω, 150Ω, 1kΩ, 33Ω, 100Ω, 1.2Ω	1 each
84.	DC Battery With Cap	9V	1 no.
85.	Dual Power Supply	(230V, 50Hz, Fuse-800mA)	1 no.
86.	Solder Iron	(350V), Solder Lead, PCB Board (Groove Board), Solder Wick	1 set
87.	Inductor	(400 Turns, 200 Turns, 600 Turns, 1200 Turns) , I-Core , E-Core, U-Core, Laminated Core	1 each
88.	Relay	(5V) , LED (5V)	1 no.
89.	Function Generator	(230V, 50Hz, Watts-12VA, Fuse-150mA)	1 no.

90.	Bread Board		1 no.
91.	Synchronous Motor	(240V, 60rpm), Capacitor For Synchronous Motor (0.8mf ± 5% 450 VAC)	1 no.
92.	Power Chord	Connecting Probes, Single Strand & Multi strand Wires.	As required
ii) Tool list for Sensors			
93.	Power Supply	(0-30V DC, 3A)	1 no.
94.	**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		
	XI. Motor With Control Unit	(24V DC,1A)	
C. MILLING CUTTERS			
95.	Milling Cutter - Cylindrical Cutter	Ø 63 mm, 90 mm Length and 27 mm Bore Diameter	3 nos.
96.	Milling Cutter - Cylindrical Cutter	Ø 80 mm, 90 mm Length and 27 mm Bore Diameter	3 nos.
97.	Milling Cutter	Side and face cutter dia 100 X 10 X 27 mm	2 nos.
98.	Milling Cutter	Side and face cutter dia 100 X 12 X 27 mm	3 nos.
99.	Milling Cutter	Side and face cutter dia 160 X 10 X 27 mm	2 nos.
100.	Milling Cutter	Side and face cutter dia 160 X 16 X 27 mm	2 nos.
101.	Milling Cutter - Side and face cutter	dia 200 X 20 X 27 mm	3 nos.
102.	Milling Cutter - Side and face cutter	dia 80 X 8 X 27 mm	2 nos.
103.	Milling Cutter - Equal Angle Cutter	45˚/100 mm x 27 mm bore dia	2 nos.
104.	Milling Cutter - Equal Angle Cutter	60˚/100 mm x 27 mm bore dia	2 nos.
105.	Milling Cutter - Equal Angle Cutter	90˚/100 mm 27 mm bore dia	2 nos.

106.	Milling Cutter - Double Angle Unequal	Cutter 50 X 12 X 27 mm bore dia55˚	2 nos.
107.	Milling Cutter - Double Angle Unequal	Cutter 50 X 12 X 27 mm bore dia 60˚	2 nos.
108.	Milling Cutter - Double Angle Unequal	Cutter 63 X 18 X 27 mm bore dia 70˚	2 nos.
109.	Milling Cutter - Double Angle Unequal	Cutter 63 X 18 X 27 mm bore dia 75˚	1 no.
110.	Milling Cutter - Single Angle	Cutter 63 x 18 x 45˚ RH 27 mm bore dia	1 no.
111.	Milling Cutter - Single Angle	Cutter 63 x 18 x 45˚LH 27 mm bore dia	1 no.
112.	Milling Cutter - Single Angle	Cutter 63 x 18 x 60˚ LH 27 mm bore dia	1 no.
113.	Milling Cutter - Single Angle	Cutter 63 x 18 x 60˚RH 27 mm bore dia	1 no.
114.	Milling Cutter - Slitting Saw Cutter	Ø 75 x 3 X Ø 27 mm	2 nos.
115.	Milling Cutter - Slitting Saw Cutter	Ø 100 x 6 X Ø 27 mm	2 nos.
116.	Milling Cutter - Shell End Mill	Ø 50 x 36 x 27 mm, Preferably Inserted Tip Type	2 nos.
117.	Milling Cutter - Shell End Mill	Ø 75 mm x 50 x 27 mm, Preferably Inserted Tip Type	2 nos.
118.	Milling Cutter - Parallel Shank end mills	Ø 6, Ø 10 and Ø 16 are (double fluted), Ø 20 mm & Ø 25mm (four fluted)	4 nos. each
119.	Milling Cutter - T Slot Cutter with Parallel Shank	Ø 17.5 x 8 mm Width x Diameter of shank 8 mm	2 nos.
120.	Milling Cutter - Concave	Ø 63 x 6 radius x 27 mm Bore Diameter	1 nos.
121.	Milling Cutter - Convex	Ø 63 x 6 radius x 27 mm Bore Diameter	1 nos.
122.	Milling Cutter - Disc type form	(involutes form - 2 module, 20° pressure angle)	1 set
D. MEASURING INSTRUMENTS			
123.	Micrometer outside	0-25 mm Reading 0.01 mm with NABL Accredited lab. Certificate	4 nos.
124.	Micrometer outside	25-50 mm Reading 0.01 mm with NABL Accredited lab. Certificate	2 nos.
125.	Micrometer outside	50-75 mm Reading 0.01 mm with NABL Accredited lab. Certificate	1 no.

126.	Micrometer outside	75-100 mm Reading 0.01 mm with NABL Accredited lab. Certificate	1 no.
127.	Micrometer depth gauge	0-200 mm Reading 0.01 mm with NABL Accredited lab. Certificate	1 no.
128.	Digital micrometer	0-25 mm Reading 0.01 mm with NABL Accredited lab. Certificate	1 no.
129.	Vernier Caliper	Depth 200 mm /8 inches with metric & inch scale (L.C. = 0.02mm) with NABL Accredited lab. Certificate	*11 nos.
130.	Direct reading vernier caliper	0- 300 (direct reading with dial)	1 no.
131.	Digital vernier caliper	0- 300 mm	1 no.
132.	Vernier height gauge q	250 mm	1 no.
133.	Vernier gear tooth caliper		1 no.
134.	Combination set	with 300 mm rule	2 sets
135.	Vernier bevel protractor	with 150 m blade	1 no.
136.	Bevel gauge	200 mm	1 no.
137.	Telescopic Gauge	8 mm to 150 mm	1set
138.	Sine Bar	200 mm	1 no.
139.	Universal Dial Test Indicator	Plunger Type - Range 0 - 10 mm, Graduation 0.01 mm complete with Clamping Devices and Magnetic Stand	1 no.
140.	Centre Gauge com.	60°, 55° and 29°	1 no.
141.	Gauge Slip Box	Metric - 87 Pieces Set	1 set
142.	Gauge Screw Pitch	Metric -0.25 to 6 mm	2 sets
143.	Gauge - Radius Set	1 mm to 25 mm by 0.5 mm	1 set
144.	Limit plug gauges	5 mm to 25 mm by 2.5 mm	1 set
145.	Ring gauges	5 mm to 25 m by 2.5 mm (GO & NO GO)	1 set
146.	Taper gauge	M.T. No. 1, 2, 3, 4 & 5	1 set
147.	Gauge Feeler / Thickness	0.05 mm to 0.3 mm by 0.05 and 0.4 mm to 1 mm by 0.1 mm - 13 leaves	1 no.
148.	Planer gauge standard size		1 no.
149.	Magnifying glass	75 mm	2 nos.
E. FURNITURE			
150.	Steel lockers for 14 trainees		1 no.

151.	Steel chair for Instructor		1 no.
152.	Steel table for Instructor		1 no.
153.	Work bench	2400 x 1200 x 900 mm	1 no.
154.	Steel cup board	180 x 90 x 45 mm	1 no.
155.	Steel cup board	120 x 60 x 45 cm	1no.
156.	Black board with easel		1 no.
157.	First Aid Box		1 no.
F. GENERAL MACHINERY SHOP OUTFIT			
158.	Slotter	180 mm stroke (motorized) with all attachments, Motor Capacity - 0.75 KW	1 no.
159.	SS and SC centre lathe (all geared) with specification as:	Centre height 150 mm and centre distance 1000 mm along with 4 jaw chuck, Taper turning attachment, steadies, auto feed system, safety guard, motorized coolant system, with lighting arrangement and set of lathe tools, Motor Capacity - 5.5 KW	3 nos.
160.	Tool and cutter grinder	250 mm to admit 450 m between center-fully motorized work head supplied with tool rest of different types table clamps and other attachments, 3.0KW	1 no.
161.	Drilling machine pillar	20 mm capacity with drill chuck & key, 0.75 KW	1 no.
162.	Radial drill	1200 mm area motorized with tapping attachment, 3.6KW	1no.
163.	Silicon carbide grinder for carbide tipped tools		1 no.
164.	Double ended Pedestal Grinder	with 178 mm wheels(one fine and one rough wheel), 0.75 KW	1 no.
165.	Universal Milling machine with minimum specification as:	Table Length x width 1200 x 300 mm having motorized up & down movement along with auto feed arrangement and with Motor Capacity - 7.5KW following attachments such as:	2 nos.
		a. Vertical head	
		b. Slotting attachment	
		c. Rack cutting attachment	
		d. Rotary table	

		e. Dividing head f. Adaptors, arbors and collects etc. for holding straight shank drills and cutters from 3 mm to 25 mm.	
166.	Horizontal Milling Machine with minimum specification as:	Table Length x width 1200 x 300 mm having motorized up & down movement along with auto feed arrangement and 150mm Universal vice, Motor Capacity - 7.5KW	1 no.
167.	Vertical Milling Machine with minimum specification as:	Table Length x width 1200 x 300 mm having motorized up & down movement along with auto feed arrangement along with 150mm universal vice, Motor Capacity - 5.5KW	1 no.
168.	Surface Grinding Machine with minimum specification as:	Grinding machine plain surface, wheel dia. 175 mm (or near) with reciprocating table having longitudinal table traverse 200 mm (or near) fully automatic and fitted with adjustable traverse stops, machine to be fully motorized and fitted with ace guards and pumps, tank and pump fittings and also to be supplied with magnetic chuck 250 x 112 mm. Diamond tool holder, set of spanners, grease gun, oil-can and spare grinding wheel for general purpose grinding, Motor Capacity - 3.0 KW	1 no.
169.	Cylindrical grinder	Max. grinding length – 300 mm Height of centre – 130 mm Max. distance between centers – 340 mm	1 no.
170.	CNC lathe/CNC turn Centre	[specification as per Annex-A & A (I)]	As per Annex-A & A (I)
171.	CNC Vertical Machining Centre	[specification as per Annex-A &A (II)]	As per Annex-A &A (II)
172.	a) Simulator b) Desktop Computers	[specification as per Annex-A &A (II)]	As per Annex-A

			&A (II)
173.	CNC milling tools	[specification as per Annex-A &A (II)]	As per Annex-A &A (II)
174.	CNC hole machining tools	[specification as per Annex-A &A (II)]	As per Annex-A &A (II)
175.	LCD projector/ large screen TV		1 no.

NOTE:

1. All tools must be hardened, toughened and grounded.
2. No additional items are required to be provided to the batch working in the second and third shift except the items under trainees toolkit.
3. Institute having centralized computer lab may use the existing infrastructure to impart simulation training & in that case not required to procure item no. 172 (b).
4. Quantity marked with * has been increased as per the batch size.
5. Internet facility is desired to be provided in the class room.

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 & Equipment not required, if Computer LAB is available in the institute.		

ANNEXURE-A

CNC Lab						
Space and Power Requirement						
1	Space Required (in Sq. Meter):	40 (For below 8(4+4) units) 65 (For above 8(4+4) units)				
2	Power Required (in KW):	6 (For below 4(2+2) units) 12.5 (For 4(2+2) & above units)				
CNC Lab Infrastructure						
S.N.	**Name of Item**	**Category**	**Quantity**		**Unit**	**Remark**
			4 (2+2) units & Above	**Below 4 (2+2) units**		
1	CNC turn Centre [specification as per Annex-A (I)]	Machine	1	NIL	No.	Refer Instructions
2	CNC Vertical Machining Centre [specification as per Annex-A (II)]	Machine	1	NIL	No.	Refer Instructions
3	Multimedia based simulator for CNC technology and interactive CNC part programming software for turning & milling with virtual machine operation and simulation using popular operation control system such as Fanuc, Siemens, etc. (Web-based or licensed based) (12 trainees + 1faculty) ***With help of this software the trainees should be able to Write, Edit, Verify & Simulate***	Software	*21	*21	users	
4	Desktop Computers compatible to run simulation software with LAN facility	Machine	*21	*21	No.	
5	Printer - (Laser/ Inkjet)	Machine	1	1	No.	Optional
6	Air Conditioner - Split - 2.0 Ton	Machine	1	1	No.	Optional

7	UPS - 2 KVA	Machine	1	1	No.	Optional

Instructions	
a)	**For units less than 4(2+2), ITI can enter into MoU with Facilitator who will provide the Training to Trainees admitted and undergoing training in above Trades.** The Facilitator should be Government ITI, Engineering/ Polytechnic College, Recognized Training Institute, Industry, Private ITI (Facilitators are arranged in descending preference order). The Facilitator should have all the above training infrastructure. (Including CNC Machines and Multimedia software for CNC). If any of the facility is not available with facilitator then the same should be provided in the ITI. The facilities of CNC should be made available to ITI trainees at the time of examination. This clause should be part of MoU to be signed. The training provider must be within the range of 15 Km or within city whichever is less.
b)	**NOTE: -** "*It is on the discretion of the ITI that it may procure CNC simulation software with extra features in addition to the specification defined against CNC simulator*".

ANNEXURE-A (I)

Detailed specification for 2 axis CNC Lathe/ Turning centre			
1.	**MACHINE CAPACITY**	**Units**	**Size**
a	Swing over bed	mm	350 or higher
b	Turning diameter	mm	135 or higher
c	Distance between centres	mm	250 or higher
d	Maximum Turning Length	mm	200 or higher
e	Slant angle (bed or saddle)	degrees	30 to horizontal or higher
f	Cast Iron grade for bed and saddle		Grade 25 or equivalent
g	Machine net weight	kg	1500 or higher
2.	**SPINDLE**		
a	Spindle nose		A2-4 / A2-5
b	Bore through Spindle	mm	35 or higher
c	Maximum spindle speed	RPM	4000 or higher
d	Spindle power, continuous	kW	3.7 or higher
e	Minimum spindle speed @ full power	RPM	1200 or lower
f	Ty^eo^{u} drive		AC servo spindle motor (digital)
g	Chuck size	mm	135 or higher
h	Chuck type		3-jaw hydraulic, Hydraulic Power operated
i	Spindle bearing class		P4 class
j	Front Bearing Dia. (ID)	mm	60 or higher
3.	**AXES**		
a	X - axis Travel	mm	100 or higher
b	Z - axis Travel	mm	200 or higher
c	Programmable feed rate- X & Z	mm/min	10 - 10000
d	Minimum programmable command - X & Z	mm	0.001
e	Rapid traverse - X & Z	m/min	20 or higher
f	Type of drive - X & Z		AC servo motor
g	Motor torque - Z axis	Nm	3 or higher
h	Motor torque - X axis	Nm	3 or higher with brake
i	Ball screw - Z & X axes (diameter x pitch)	mm	25 x 10 or higher
j	Ball screw finish - Z & X axes		Hardened and Ground
k	Ball screw class- Z & X axes		Pre-loaded with C3 or better
l	Guideway type - Z & X axes		Antifriction linear motion guideway
m	Guideway size - Z & X axes	mm	25 or higher
n	Guideway precision - Z & X axes		P class
4.	**TURRET**		

a	Bi-Directional Tool Turret	Electromechanical/Servo/Hydraulic	
b	No. of Tools	Nos.	8 or higher
c	Tool shank size	mm	20 x 20 or higher
d	Maximum boring bar diameter	mm	25 or higher
5.	**TAIL STOCK**		
a	Quill Diameter	mm	65 or higher
b	Quill Stroke	mm	70 or higher
c	Quill Taper	MT-4 or higher	
d	Quill actuation		Hydraulic
e	Tail stock base travel manual	mm	150 or higher
f	Thrust (Adjustable)	Kgf	300 or higher
6.	**COOLANT/LUBRICATION/HYDRAULIC**		
a	Coolant tank capacity	Litres	100 or higher
b	Coolant pump motor	kW	0.37
c	Coolant pump output	LPM	20 or higher
d	Lubrication type		Automatic centralized lubrication
e	Lubrication tank capacity	Litres	3 or higher
f	Hydraulic pump discharge	LPM	8 or higher
g	Hydraulic tank capacity	Litres	30 or higher
h	Hydraulic system pressure maximum	Bar	30 or higher
7.	**ACCURACY as per ISO 230-2**		
a	Positioning accuracy X & Z axes	mm	0.012
b	Repeatability X & Z axes	mm	± 0.007
c	Geometrical Alignment		ISO 13041-Part 1
d	Accuracy of finish test piece		ISO 13041-Part 6
8.	**CNC SYSTEM**		
a	Control System	FANUC/Siemens	
b	System resolution	0.001 mm	
c	Motors & Drives	Compatible with CNC controllers mentioned above	
d	Tool number display	On machine operator panel	
e	Machine control panel	Feed rate, spindle speed override knob	
f	MPG (Manual pulse generator)	On machine operator panel	
g	CNC features	Graphic Simulation, Programming help, Tool Offsets, MDI,	
		Absolute/ Incremental Positioning, Pitch error compensation	
9.	**POWER SOURCE**		
a	Mains supply (± 10 %)	415 V, 3 Ph., 50Hz	
b	Total connected load requirement	Approx. 15 kVA	
10.	**STANDARD EQUIPMENT**		
a	Voltage Stabilizer	15 kVA	

b	Air conditioning unit for electrical cabinet	1 no.	
	Backup CD for PLC Ladder Logic	1 no.	
d	Machine lighting	1 no.	
e	Levelling pads and jacking screws	4 no.	
f	Operation manual	1 no.	
g	Maintenance manual	1 no.	
h	Installation kit	1 no.	
i	Maintenance tool kit	1 no.	
j	6 rack trolley (Size 25"x22"x45")with lock	1 no.	
k	Machine guarding with safety compliance	1 no.	

11.	**MAKES OF CRITICAL MACHINE TOOL COMPONENTS**	
a	Linear Motion Guideways	HIWIN/THK/PMI/STAR
b	Ball Screws	HIWIN/THK/TSUBAKI/PMI/STAR/HMT/NSK
c	Spindle Bearings	RHP/NSK/FAG/SKF/NRB
d	Turret	PRAGATI/BARUFFALDI/SAUTER/DUPLOMATIC
e	Hydraulic Chuck & Cylinder	GMT/KITAGAWA/AIRTECH/PRAGATI/ROHM
f	Hydraulic Power Pack	YUKEN/FLUID/REXROTH
g	Panel AC	WERNER FINLEY/RITTAL/LEXTECNOID
h	Stabilizer	NEEL/SERVOMAX/CONSUL/FARMAX/EQUIVALENT
i	Lubrication	CENLUBE/DROPCO/EQUIVALENT
j	Coolant Pump	RAJAMANE/GRUNDFOS
k	Cutting tools and holders	SANDVIK/TAEGUTEC/KENNAMETAL/SECO/ISCAR/MITSUBISHI

12.	**Cutting tools & tool holders**	**Quantity**		**Inserts**	**Quantity**	
		1 year	**3 years**		**1 year**	**3 years**
a)	External turning holder, insert type, MWLNL	2	4	WNMG	20	40
b)	External turning holder, insert type, MVJNL	2	4	VNMG	10	20
c)	External turning holder, insert type, PDJNR	2	4	DNMG	10	20
d)	Threading Holder - External, LH	2	4	0.5 to 2	10	30
e)	Threading Holder - Internal, LH	2	4	0.5 to 2	10	30
f)	Grooving Holder External, LH	2	4	3 mm	10	30
g)	Grooving Holder Internal, LH	2	4	3 mm	10	30
h)	Parting off Holder for insert width 2 mm, LH	2	4	2 mm	10	30
i)	Boring holder SCLCL for minimum bore dia. 12 mm	2	4	WCMT	20	60
j)	Boring holder SCLCL for minimum bore dia. 16 mm	2	4	CCMT	20	60
k)	Internal grooving holder LH, for minimum bore dia. 12 mm.	2	4	2 mm	10	30

l)	Internal threading holder LH, for minimum bore dia. 12 mm	2	4	w mm	10	30
m)	Insert drill 12.7 mm	2	4	Suitable	10 sets	30 sets
n)	Reducing sleeves for internal holders - Dia 12 and 16 mm	1 set	2 sets			
o)	Centre drill HSS A 2.5 x 6.3	2	6			
p)	Twist drill HSS straight shank, dia 6,8,10,12 mm	2 Sets	6 sets			
q)	Collets suitable for the above drills	1 Set	2 sets			
r)	Collet Holder	2	4			
s)	Boring bar holder	3	3			

ANNEXURE-A (II)

Detailed specification for CNC Vertical Machining Centre			
1.	**MACHINE CAPACITY**	**Units**	**Size**
a	Table size	mm	500x250 or higher
b	Max. load on table	Kg	150 or higher
c	T slot dimension (N x W x P)	mm	3 x 14 x 100 or higher
d	Table height from floor	mm	800 ~ 900
e	Cast Iron grade for bed and saddle		Grade 25 or equivalent
f	Machine net weight	kg	1500 or higher
2.	**SPINDLE**		
a	Spindle nose		BT30 / BT40
b	Minimum distance (spindle nose to table)	mm	100 - 150
d	Maximum spindle speed	RPM	6000 or higher
e	Spindle power, continuous	kW	3.7 or higher
f	Type of drive		AC servo spindle motor (digital)
g	Spindle bearing class		P4
h	Front Bearing Dia. (ID)	mm	50 or higher
3.	**AXES**		
a	X - axis Travel	mm	300 or higher
b	Y - axis Travel	mm	250 or higher
c	Z - axis Travel	mm	250 or higher
d	Rapid traverse - X/Y/Z	m/min	20/20/20 or higher
e	Minimum programmable command- X/Y/ Z	mm	0.001
f	Programmable feed range - X, Y & Z axes	mm/min	10 - 10000
g	Type of drive		AC servo motor
h	Motor Torque - X & Y axes	Nm	3 or higher
i	Motor torque - Z axis	Nm	6 or higher with brake
j	Ball screw - X, Y & Z axes (diameter x pitch)	mm	25 x 10 or higher
k	Ball screw finish - X, Y & Z axes		Ground and hardened
l	Ball screw class - X, Y & Z axes		Pre-loaded with C3 or better
m	Guideways - X, Y & Z axes		Antifriction linear motion guideway
n	Guideways size - X, Y & Z axes	mm	25 or higher
o	Guideway precision - X, Y, & Z axes		P Class
4.	**AUTOMATIC TOOL CHANGER**		
a	Number of tool pockets	Nos	8 or higher
b	Max tool diameter	mm	80 or higher
c	Tool selection		Bi-directional

d	Tool shank type	BT30 / BT40	
e	Tool weight max	kg	2.5 for BT30 / 6 for BT40
f	Tool length max	mm	100 ~150 for BT30 / 150~200 for BT40
g	Tool change time (chip to chip)	sec	5 or lower
h	Tool clamp & unclamp	Disc Spring & Hydro-Pneumatic	
5.	**ACCURACY as per ISO 230-2**		
a	Positioning accuracy for X,Y & Z axes	mm	0.012
b	Repeatability for X,Y & Z axes	mm	±0.007
c	Geometrical Alignment		ISO 10791-Part 1
d	Accuracy of finish test piece		ISO 10791-Part 7
6.	**CNC SYSTEM**		
a	Control System	FANUC/Siemens	
b	Motors & Drives	Compatible with CNC controllers as mentioned above	
c	System resolution	0.001 mm	
d	Tool number display	On machine operator panel	
e	Machine control panel	Feed rate, spindle speed override knob	
f	MPG (Manual pulse generator)	On machine operator panel	
g	CNC Features	Graphic Simulation, Programming help, Tool Offsets MDI	
		Absolute/Incremental Positioning, Pitch error compensation	
7.	**COOLANT/LUBRICATION**		
a	Coolant tank Capacity	Litres	100 or higher
b	Coolant pump motor	kW	0.37
c	Coolant pump output	lpm	20 or higher
d	Lubrication type		Automatic centralized lubrication
e	Lubrication tank capacity	Litres	3 or higher
8.	**AIR COMPRESSOR FOR TOOL UNCLAMP**		
a	Compressor Type		Screw type with dryer, filter & air receiver
b	Tank capacity	litres	200 or higher
c	Air Flow	CFM	10 or higher
d	Pressure	bar	7 max.
9.	**POWER SOURCE**		
a	Mains supply (± 10 %)		415 V, 3 Ph., 50Hz
b	Total connected load requirement		Approx. 15 kVA
10.	**STANDARD EQUIPMENT**		
a	Voltage Stabilizer	15 kVA	

b	Air conditioning unit for electrical cabinet	1 no.	
c	Backup CD for PLC Ladder Logic	1 no.	
d	Machine lightning	1 no.	
e	Leveling pads and jacking screws	4 nos.	
f	Operation manual	1 no.	
g	Maintenance manual	1 no.	
h	Installation kit	1 no.	
i	Maintenance tool kit	1 no.	
j	6 rack tool trolley (Size 25"x22"x45") with lock	1 no.	
h	Machine guarding with safety compliance	1 no.	
11.	**MAKES OF CRITICAL COMPONENTS**		
a	LM guideways	HIWIN/THK/PMI/STAR	
b	Ball Screws	HIWIN/THK/TSUBAKI/PMI/STAR/HMT/NSK	
c	Spindle Bearings	RHP/NSK/FAG/SKF/NRB	
d	ATC	PRAGATI/GIFU	
e	Panel AC	WERNER FINLEY/RITTAL/LEXTECNOID	
f	Stabilizer	NEEL/SE RVOMAX/CONSUL/FARMAX	
g	Lubrication	CENLUBE/DROPCO	
h	Coolant Pump	RAJAMANE/GRU NDFOS	
i	Cutting tools and holders	SANDVIK/TAEGUTEC/KEN NAMETAL/SECO/MITSUBISHI	
j	Air compressor (capacity: 6 kg/cm2 - 300 lpm min.)	GODREJ/ELGI/KAESER/ATLASCOPCO	

12.	**Cutting Tools & Tool Holders (for BT30 or BT40 as per machine supplied)**					
S No.	**Item**	**Quantity**		**Inserts**	**Quantity**	
		1 year	**3 years**		**1 year**	**3yrs**
a.	Face mill 45 degree 63 mm., insert type	2	4	Suitable inserts	5 sets	15
b.	Face mill square shoulder 50 mm., insert type	2	4	Suitable inserts	5 sets	15
c.	Twist drill HSS straight shank 6, 6.7, 8.5, 9.7	2	4		20	60
d.	Spot drill Carbide, dia. 8 mm X 90°	2	4		20	60
e.	Drill insert type - 16 mm.	2	4	Suitable inserts	10	30
f.	Solid carbide Twist drill straight shank - 8 mm	2	4			
g.	Solid carbide End mill straight shank - 10, 12 mm dia.	2	4			
h.	End mill insert type straight shank - 16 mm dia.	2	4	Suitable inserts	10	30

i.	Machine Taps HSS - M8, M10	2	4		10	30
j.	Solid carbide Reamer straight shank - 10 mm	2	4		10	30
k.	Finish boring bar dia. 20 to 25 mm	1	3	Suitable inserts	10	30
l.	Holder for face mills (Adapter)	2	4		20	60
m.	Collets for above drills, reamers, end mills	2 sets	4 sets			
n.	Collet holder suitable for collets	4	4			
o.	Side lock holder for 16 mm insert drill	1	2			
p.	Machine vice 0-150 mm range - Mechanical type	1	1			
q.	C spanner for tightening tools in holder	1	2			
r.	Magnetic dial stand	1	2			
s.	Mallet	2	4			
t.	Tap wrench	1	2			
u.	Hands tools set (spanners, Allen keys, etc.)	1 box				
v.	T Nuts, Strap clamps, Clamping Nuts and studs	1 set				
w.	Tap wrench	1	2			
x.	Hands tools set (spanners, Allen keys, etc.)	1 box				
y.	T Nuts, Strap clamps, Clamping Nuts and studs	1 set				

ANNEXURE-II

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.	**Candidate Name**	**Father's/Mother's Name**	Safety Consciousness	Workplace Hygiene & Economical use of materials	Attendance/ Punctuality	Ability to follow Manuals/ Written instructions	Application of Knowledge	Skills to Handle Tools/ Equipment/ Instruments/ Devices	Economical use of Materials	Working Strategy	Quality in Workmanship/ Performance	VIVA	**Total Internal Assessment Marks**	**Result (Y/N)**
Maximum Marks (Total 100 Marks)			**15**	**5**	**10**	**5**	**10**	**10**	**5**	**10**	**15**	**15**		
1														
2														