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

COMPETENCY BASED CURRICULUM

TECHNICIAN MECHATRONICS

(Duration: Two Years)

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL- 4

SECTOR –CAPITAL GOODS AND MANUFACTURING

Directorate General of Training

TECHNICIAN MECHATRONICS

(Engineering Trade)

(Revised in March 2023)

Version: 2.0

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL - 4

Developed By

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1. COURSE INFORMATION

During the twoyears duration a candidate is imparted training on subjects Professional Skill, Professional Knowledge and Employability Skills related to job role. 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 practical task.

The course broadly covers all aspect of Skills required to work in the field of Mechatronics.

FIRST YEAR: In this year, the practical part starts with basic fitting work to make job as per specification applying different types of basic Fitting and machining viz., Drilling, Turning, Milling and Grinding operations. The trainee will be able to Produce components by different operations and check accuracy using appropriate measuring instrument. Apply different fits for assembling of components as per required tolerance, observing principle of interchangeability and check for functionality. Produce components involving different operation on Lathe, Milling and Grinding machine observing standard procedure and check for accuracy. The candidates also learn about basic computer operation such as MS-Office and basic troubleshooting related to the computer. The welding and brazing are also covered during this year. The safety aspects cover components like OSH&E, PPE, Fire extinguisher, First Aid and in addition 5S of Kaizen is being taught.

The imparted training on basic Electrical and Electronics sub-systems and its measuring techniques using appropriate Measuring instruments, Operate and troubleshoot AC/DC machines and drives. Acquire the skill of reading and analyzing Electrical and Electronics drawings. Construct, analyze and troubleshoot Electrical and Electronic circuits. Assemble and Disassemble Electrical and Electronic components by Soldering and de-soldering techniques. Carry out Industrial panel wiring. Understand and troubleshoot Protective devices in Electrical system. Understand the Digital logic circuits and its applications. Acquire computer skills such as Software installation. Knowledge onbasicprogramming of Microcontroller and its Interfacing techniques, troubleshooting of electrical & electronics system are also covered.

SECOND YEAR: Operates CNC turn centre and CNC milling machine to produce simple components. The trainee also gets knowledge of different sensors viz., inductive, capacitive, magnetic etc and carries out related practical on the same. The student understands the principles of hydraulics, the basic functions of hydraulic systems andthe functions of valves (flow control, pressure control, directional control). Attain the skill of reading and analyzing

Hydraulic and Pneumatic drawings. Recognize circuit symbols and diagrams to ISO 1219, construct basic hydraulic circuits as per drawings, understand and follow safe practice.Acquire the knowledge on the functions of power packs, pumps, filters and reservoirs.Understand the units and measurement scales associated with compressed air system.Understand the functioning of standard pneumatic cylinders and valves, read pneumatic circuit diagrams and understand Pneumatic symbols. Construct simple pneumatic controls as per drawing.Read, understand and analyze Electro-Pneumatic circuit diagrams, understand fundamental terminology and symbols of Electro-Pneumatic control, understand the function and operation of a range of proximity sensors, read, interpret and construct motion diagrams. Construct multi-cylinder control circuit.Fault diagnostics procedure and Troubleshooting of Hydraulics and Pneumatics sub-systems. Executes programming on PLC.

The Trainee gets awareness on Robotics and its application, the trainee will be able to develop, test and troubleshoot circuits using simulator software for Electrical, Electronics, Hydraulic and Pneumatic systems. Able to fabricate and assemble while working model project on Mechatronics [Example: Project-“Pick and Place Mechatronics system” involving Fitting, Drilling, Turning, Milling, Grinding, Electrical wiring, programming, Hydraulic circuit assembly, Pneumatic circuit assembly, Drives, system assembly and Interfacing, functional testing, trouble shooting and repair. Safety measures in each stage.]

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 Directorate General of Training (DGT). Craftsman Training Scheme (CTS) with variants and Apprenticeship Training Scheme (ATS) are two pioneer schemes of DGT for strengthening vocational training.

CTS courses are delivered nationwide through network of ITIs. The course 'Technician Mechatronics' is of two-year duration. It mainly consists of trade (skills and knowledge) and Core area (Employability Skills). After passing out of the training program, the trainee is awarded National Trade Certificate (NTC) by DGT which is recognized worldwide.

Trainee broadly needs to demonstrate that they are able to:

- Read & 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 of a Technician Mechatronics 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 PROGRESSION PATHWAYS:

- Can join industry as Technician and will progress further as Senior Technician, Supervisor and can rise up to the level of Manager.
- Can become Entrepreneur in the related field.
- Can take admission in diploma course in notified branches of Engineering by lateral entry.
- Can join Apprenticeship programme in different types of industries leading to a National Apprenticeship certificate (NAC).
- Can join Crafts Instructor Training Scheme (CITS) in the trade for becoming an instructor in ITIs.

- Can join Advanced Diploma (Vocational) courses under DGT as applicable.

2.3 COURSE STRUCTURE:

Table below depicts the distribution of training hours across various course elements during a period of two-year is as follows:

S No.	Course Element	Notional Training Hours	
		1st Year	2nd Year
1	Professional Skill (Trade Practical)	840	840
2	Professional Knowledge (Trade Theory)	240	300
3	Employability Skills	120	60
	Total	**1200**	**1200**

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

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

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

2.4 ASSESSMENT & CERTIFICATION

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

a) The **Continuous Assessment** (Internal)during the period of training will be done by **Formative Assessment Method** by testing for assessment criteria listed against learning outcomes. The training institute have to maintain individual *trainee portfolio* as detailed in assessment guideline. The marks of internal assessment will be as per the formative assessment template provided on www.bharatskills.gov.in.

b) The final assessment will be in the form of summative assessment. The All India Trade Test for awarding NTC will be conducted by Controller of examinations, DGT as per the guidelines.

The pattern and marking structure is being notified by DGT from time to time. **The learning outcome and assessment criteria will be basis for setting question papers for final assessment. The examiner during final examination will also check** individual trainee's profile as detailed in assessment guideline before giving marks for practical examination.

2.4.1 PASS REGULATION

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

2.4.2 ASSESSMENT GUIDELINE

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

Assessment will be evidence based comprising some of the following:

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

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

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

3. JOB ROLE

Technician Mechatronics; are generalized trade-technician workers. Mechatronics technicians will usually assist design, development and engineering staff, as well as working closely with other trades persons to install, maintain, modify and repair Mechatronics systems, equipment and component parts.

Technician Mechatronics may

- Fit and assemble parts and sub-assemblies made from mechanical and electrical - electronic and computer components
- Manufacture, install, modify, repair and fault-find hydraulic and pneumatic equipment and systems
- Inspect machinery and make repairs
- Erect machinery and equipment on site
- Examine detailed drawings or specifications to find out job, material and equipment requirements
- Set up and adjust machines and equipment
- Operate machines to produce parts and components
- Cut, thread, bend and install hydraulic and pneumatic pipes and lines
- Dismantle faulty tools and assemblies and repair or replace defective parts
- Set up and-or operate hand and machine tools and equipment.
- Check accuracy and quality of finished parts, tools or sub-assemblies.

Mechatronics technicians build automated systems for industry. Mechatronics involves mechanics, electronics, and pneumatics and computer technology. The computer technology element covers information technology applications, programmable machine control systems, and technology which enable communication between machines, equipment and people.

In addition Technician Mechatronics have the ability to visualize the job, good coordination, mechanical attitude, manual dexterity and perform work related mathematical calculations.

Plan and organize assigned work and detect and 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.

Reference NCO-2015:

a) 7233.0100 - Fitter, General
b) 7233.0101 - General Maintenance Fitter-Mechanical

c) 7412.0101 - Automation Specialist
d) 7412.0201 - Fitter-Electrical and Electronic Assembly
e) 7411.0100 - Electrician, General
f) 7421.0300 - Electronics Mechanic

Reference NOS:

a) TSC/N5702
b) TSC/N9015
c) TSC/N5703
d) CSC/N0304
e) AAS/N9407
f) CSC/N0109
g) CSC/N0110
h) CSC/N9407
i) ELE/N4063
j) ELE/N0102
k) CSC/N0305
l) PSS/N6002
m) PSS/N9407
n) SSC/N9416
o) ELE/N9417
p) ELE/N9495
q) CSC/N9463
r) ELE/N9408
s) ELE/N9489
t) CSC/N9488
u) CSC/N9468
v) ELE/N9426
w) ELE/N9490
x) ELE/N7118
y) CSC/N9473
z) ELE/N7110
aa) ELE/N7109
bb) PSS/N9401
cc) PSS/N9402

4. GENERAL INFORMATION

Name of the Trade	**TECHNICIAN MECHATRONICS**
Trade Code	DGT/2001
NCO - 2015	7233.0100, 7233.0101, 7412.0101, 7412.0201, 7411.0100, 7421.0300
NOS Covered	TSC/N5702, TSC/N9015, TSC/N5703 CSC/N0304, AAS/N9407, CSC/N0109, CSC/N0110, CSC/N9407, ELE/N4063, ELE/N0102, CSC/N0305, PSS/N6002, PSS/N9407, SSC/N9416, ELE/N9417, ELE/N9495, CSC/N9463, ELE/N9408, ELE/N9489, CSC/N9488, CSC/N9468, ELE/N9426, ELE/N9490, ELE/N7118, CSC/N9473, ELE/N7110, ELE/N7109, PSS/N9401, PSS/N9402
NSQF Level	Level – 4
Duration of Craftsmen Training	Two Years (2400 hours + 300 hours OJT/Group Project)
Entry Qualification	Passed 10th class examination with Science and Mathematics or with vocational subject in same sector or its equivalent.
Minimum Age	14 years as on first day of academic session.
Eligibility for PwD	LD,LC,DW,AA,LV,DEAF
Unit Strength (No. Of Student)	24(There is no separate provision of supernumerary seats)
Space Norms	192 Sq.m.
Power Norms	8 KW
Instructors Qualification for	
1. Technician Mechatronics Trade	B.Voc/Degree in Mechatronics / Mechanical/ Instrumentation / Electrical Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field. OR 03 years Diploma in Mechanical/ Electrical/ Instrumentation/ Mechatronics Engineering from AICTE recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. OR NTC/NAC passed in the Trade of "Technician Mechatronics" With 3 years' experience in the relevant field. **<u>Essential Qualification</u>:** Relevant Regular / RPL variants of National Craft Instructor Certificate (NCIC) under DGT. **<u>NOTE:-</u>*Out of two Instructors required for the unit of 2(1+1), one must have Degree/Diploma and other must have NTC/NAC qualifications. However both of them must possess NCIC in any of its variants.***
2. Workshop	B.Voc/Degree in Engineering from AICTE/UGC recognized Engineering

Calculation & Science	College/ university with one-year experience in the relevant field. **OR** 03 years Diploma in Engineering from AICTE / recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. **OR** NTC/ NAC in any one of the engineering trades with three years' experience. **Essential Qualification:** Regular / RPL variants of National Craft Instructor Certificate (NCIC) in relevant trade **OR** Regular / RPL variants NCIC in RoDA or any of its variants under DGT
3. Engineering Drawing	B.Voc/Degree in Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field. **OR** 03 years Diploma in Engineering from AICTE / recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. **OR** NTC/ NAC in any one of the engineering/ Draughtsman group of trades with three years' experience. **Essential Qualification:** Regular / RPL variants of National Craft Instructor Certificate (NCIC) in relevant trade OR Regular/RPL variants NCIC in RoDA or any of its variants under DGT
4. Employability Skill	MBA/ BBA / Any Graduate/ Diploma in any discipline with Two years' experience with short term ToT Course in Employability Skills. (Must have studied English/ Communication Skills and Basic Computer at 12th / Diploma level and above) OR Existing Social Studies Instructors in ITIs with short term ToT Course in Employability Skills.
5. Minimum Age for Instructor	21 Years
List of Tools and Equipment	As per Annexure – I

5. LEARNING OUTCOME

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

5.1 LEARNING OUTCOMES (TRADE SPECIFIC)

FIRST YEAR:

1. Plan and organize the work to make job as per specification applying different types of basic fitting operation and check for dimensional accuracy following safety precautions. *[Basic fitting operation – Filing, Marking, Hack sawing, Drilling, Taping, chipping and Grinding etc. Accuracy: ± 0.1mm]* (CSC/N0304)
2. Perform different fit of components for assembling as per required tolerance observing principle of interchangeability and check for functionality. *[Different Fit –Open & Square Fit; Required tolerance: ±0.05 mm]* (AAS/N9407)
3. Produce components involving different operations on Lathe, Milling and Grinding machines observing standard procedure and check for accuracy. *(Different Operations – facing, plain turning, step turning, parting, chamfering, shoulder turn, grooving, knurling, threading (external 'V' only), plain milling, step milling, grooving, slot milling, profile milling, surface grinding and cylindrical grinding (internal and external)* (CSC/N0109, CSC/N0110, CSC/N9407)
4. Perform different computer operation and troubleshoot. [*Different computer operations: setting of computer & MS Office operation]* (ELE/N4063)
5. Perform joining of metals by welding and brazing observing standard procedure. (ELE/N0102)
6. Construct different electrical sub-systems and measure parameters. *[Different electrical sub-systems: - AC/DC Motors, DC machine, DC motors, DC motor starter, Universal motor, Induction motor, AC drive, Servo drive, transformer.]* (CSC/N0305)
7. Construct different electronics sub system and test electronic devices and sub system. *[Different sub system: - Diodes, rectifier circuit, voltage regulator, transistor power electronic devices, op-amp circuit, LED circuit, SCR etc.]* (PSS/N6002)
8. Estimate and perform panel wiring using cables, connectors, Protective devices and test functionality. (PSS/N9407)
9. Construct and verify different Digital Logic Circuits. *[Different DLC:- Logic Gates, half & full adder, binary & outer, P/ down counter.]* (SSC/N9416)
10. Install different software in computer system and test. *[Different software: Office, Multimedia, Fluidism, PLC, etc.]* (ELE/N9417)
11. Write an assembly level programme and interface peripherals to 8051 Microcontroller to check functioning. (ELE/N9495)
12. Troubleshoot and repair different Electrical, Electronic systems/ devices. *[Different Electrical, Electronic systems/ devices:- Fuse, MCB, Power circuit, Control panel, Circuit Breaker, Stabilizer, AC/DC drives.]* (CSC/N9463)

13. Demonstrate function of different sensors. *[Different sensors: Proximity Sensors, inductive sensor, capacitive sensor, magnetic sensor, Reflex Photoelectric Sensors, Temperature Sensors, etc.]* (ELE/N9408)
14. Read and apply engineering drawing for different application in the field of work. PSS/N9401
15. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. PSS/N9402

SECOND YEAR:

16. Set (both job and tool) CNC turn centre and milling machine to produce simple components as per drawing. (TSC/N5702, TSC/N9015)
17. Construct simple pneumatic control system to measure various parameters using transducer, sensor and switches. *[Various parameter: pressure, flow, level of oil, load displacement] (*TSC/N9015)
18. Check various components of pneumatics system and construct pneumatic circuit to check functionality. *(*TSC/N9015)
19. Construct an electro-pneumatic circuit and check functionality of a process. *[E.g.- process: Automatic braking system.]* (ELE/N9489)
20. Install an electro-pneumatic system and trouble shoot faults. (ELE/N9489)
21. Construct simple hydraulic circuit and check functionality. (CSC/N9488)
22. Demonstrate installation of accessories in hydraulic system and troubleshoot defects. (CSC/N9468)
23. Construct hydraulic circuit; verify various processes to assess functioning of valves and auxiliaries. *[Various processes: - speed control, lub system, press control etc.]* (ELE/N9426)
24. Install hydraulic pump, motors and carryout maintenance of these components. *(*TSC/N5702, TSC/N5703, TSC/9015)
25. Construct different hydraulic system and operate to achieve desired functions. *[Different hydraulic system:- Clamp control, injection control, reciprocating screw, oil filtration, hydraulic press control, accumulator control.]* (ELE/N9489)
26. Programme PLC and interface with other devices to check its Applications. (ELE/N9490)
27. Explain robot anatomy and perform programming robot using teach box, software. (ELE/N7118)
28. Simulate the electrical circuits on simulation software and detect fault as per diagnostic procedure for Electrical system design. (CSC/N9473)
29. Simulate the electronic circuits on simulation software and detect fault as per diagnostic procedure for Electronics system design. (ELE/N7110)
30. Simulate the Hydraulic and Pneumatic circuit on simulation software and detect fault as per diagnostic procedure for Hydraulics and Pneumatics system design. (ELE/N7109)
31. Perform project work on Mechatronics (*Project-"Pick and Place Mechatronics system" involving Fitting, Drilling, Turning, Milling, Grinding, Electrical wiring, programming, Hydraulic circuit assembly, Pneumatic circuit assembly, Drives, system assembly and*

Interfacing, functional testing, trouble shooting and repair. Safety measures in each stage). (CSC/N0304)

32. Read and apply engineering drawing for different application in the field of work. PSS/N9401
33. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. PSS/N9402

6. ASSESSMENT CRITERIA

LEARNING OUTCOMES	ASSESSMENT CRITERIA
FIRST YEAR	
1. Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check for dimensional accuracy following safety precautions. *[Basic fitting operation – Filing, Marking, Hack sawing, Drilling, Taping, chipping and Grinding etc. Accuracy: ± 0.1mm]* (CSC/N0304)	Plan and Identify tools, instruments and equipment for marking and make this available timely.
	Select raw material and visual inspection for defects.
	Mark as per specification applying desired mathematical calculation and observing standard procedure.
	Identify Hand Tools for different fitting operations and make these available timely.
	Prepare the job for Hack sawing, chiselling, filing.
	Perform basic fitting operations viz., Hack sawing, filing and Chipping of close tolerance as per specification to make the job.
	Observe safety procedure during above operations as per standard norms and guidelines.
	Measure and Check all dimensions of the work pieces as per standard procedure in accordance with specifications and tolerances.
	Identify unused materials and components for storing in an appropriate environment and prepare for disposal.
2. Perform different fit of components for assembling as per required tolerance observing principle of interchangeability and check for functionality. *[Different Fit –Open & Square Fit; Required tolerance: ±0.05 mm]* (AAS/N9407)	Recognize general concept of Limits, Fits and tolerances necessary for fitting applications and functional application of these parameters.
	Plan and Identify tools, instruments and equipment for workpiece and make this available timely.
	Set up workplace/ assembly location with due consideration to operational stipulation.
	Plan work in compliance with standard safety norms and collecting desired information.
	Demonstrate possible solutions and agree tasks within the team.
	Make components according to the specification for different fits using a range of practical skills including scraping and ensuring interchange ability of different parts.
	Measure the components using Vernier, Micrometer and Height gauge.
	Assemble components applying a range of skills to ensure proper fit.
	Check functionality of components.
3. Produce components involving different operations on Lathe,	Ascertain basic working principles and safety aspects of machines.
	Understand functional application of different levers, stoppers, adjustment etc.

Milling and Grinding machines observing standard procedure and check for accuracy. *(Different Operations – facing, plain turning, step turning, parting, chamfering, shoulder turn, grooving, knurling, threading (external 'V' only), plain milling, step milling, grooving, slot milling, profile milling, surface grinding and cylindrical grinding (internal and external)* (CSC/N0109, CSC/N0110, CSC/N9407)	Identify different lubrication points and lubricants, their usage for application in machines as per machine manual.
	Identify different work and tool holding devices and collect information for functional application of each device.
	Mount the work and tool holding devices with required alignment and check for its functional usage to perform machining operations.
	Solve problem by applying basic methods, tools, materials and information during setting.
	Observe safety procedure during mounting as per standard norms.
	Produce components observing standard procedure.
	Check accuracy/ correctness of job using appropriate equipment/gauge.
	Identify unused materials and components for storing in an appropriate environment and prepare for disposal.
4. Perform different computer operation and trouble shoot. *[Different computer operations: setting of computer & MS Office operation]* (ELE/N4063)	Collect relevant information to operate and trouble shoot computer.
	Set the computer and carryout basic computer related operation using MS Office.
	Conduct basic trouble shooting of PC.
5. Perform joining of metals by welding and brazing observing standard procedure. (ELE/N0102)	Plan and select the type & size of electrode, welding current, nozzle size, working pressure type of flame, filler rod and flux as per requirement as per process requirement.
	Prepare edge as per requirement.
	Prepare, set SMAW machine/Gas welding plant and tack the pieces as per drawing.
	Set up the tacked pieces in specific position.
	Deposit the weld maintaining appropriate arc length, electrode angle, welding speed, weaving technique / Braze the joint adapting proper brazing technique and safety aspects.
	Clean the welded joint thoroughly.
	Carry out visual inspection for appropriate weld joint & check by gauges.
6. Construct different electrical sub-systems and	Plan and identify tools, instruments and equipment for the work and make it available timely.

measure parameters. *[Different electrical sub-systems: - AC/DC Motors, DC machine, DC motors, DC motor starter, Universal motor, Induction motor, AC drive, Servo drive, transformer.]* (*CSC/N0305)*	Set up workplace/ assembly location with due consideration to operational stipulation.
	Plan work in compliance with standard safety norms and collecting desired information.
	Demonstrate possible solutions and agree tasks within the team.
	Troubleshoot & test different electrical sub system.
7. Construct different electronics sub system and test electronic devices and sub system. *[Different sub system: - Diodes, rectifier circuit, voltage regulator, transistor power electronic devices, op-amp circuit, LED circuit, SCR etc.]* (PSS/N6002)	Plan and identify tools, instruments and equipment for the work and make it available timely.
	Set up workplace/ assembly location with due consideration to operational stipulation.
	Plan work in compliance with standard safety norms and collecting desired information.
	Demonstrate possible solutions and agree tasks within the team.
	Construct different electronics subsystem test electronics devices and subsystems.
8. Estimate and perform panel wiring using cables, connectors, Protective devices and test functionality. (PSS/N9407)	Plan and estimate material requirement for panel wiring.
	Identify tools equipment for the work and make it available timely.
	Set up workplace/ assembly location with due consideration to operational stipulation.
	Plan work in compliance with standard safety norms and collecting desired information.
	Perform panel wirings.
9. Construct and verify different Digital Logic Circuits. *[Different DLC:- Logic Gates, half & full adder, binary & outer, P/ down counter.]* (SSC/N9416)	Plan and identify tools, instruments and equipment for the work and make it available timely.
	Construct and verify digital logic circuits.
10. Install different software in computer system and test. *[Different software: Office, Multimedia, Fluidism, PLC, etc.]* (ELE/N9417)	Identify different components/ parts of PC.
	Collect relevant information for installing software.
	Check operation of computers.
	Install software in the computer and check its functioning.

11. Write an assembly level programme and interface peripherals to 8051 Microcontroller to check functioning. (ELE/N9495)	Write Basic Assembly language Programming.
	Interface peripherals to 8051 Microcontroller.
	Check the functioning as per programme.
12. Troubleshoot and repair different Electrical, Electronic systems/ devices. *[Different Electrical, Electronic systems/ devices:- Fuse, MCB, Power circuit, Control panel, Circuit Breaker, Stabilizer, AC/DC drives.]* (CSC/N9463)	Plan and identify tools, instruments and equipment for the work and make it available timely.
	Plan work in compliance with standard safety norms and collecting desired information.
	Demonstrate possible solutions and agree tasks within the team.
	Trouble shoot and repair electrical & electronics system/ devices observing safety procedure.
	Check the functionality of the system.
13. Demonstrate function of different sensors. *[Different sensors: Proximity Sensors, inductive sensor, capacitive sensor, magnetic sensor, Reflex Photoelectric Sensors, Temperature Sensors, etc.]* (ELE/N9408)	Demonstrate the Behaviour of Proximity Sensors and ultra sonic sensors and logic operation of sensors.
	Limits and level control using sensors.
	Interfacing of sensors with electrical actuators.
14. Read and apply engineering drawing for different application in the field of work. (PSS/N9401)	Read & interpret the information on drawings and apply in executing practical work.
	Read &analyze the specification to ascertain the material requirement, tools and assembly/maintenance parameters.
	Encounter drawings with missing/unspecified key information and make own calculations to fill in missing dimension/parameters to carry out the work.
15. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain	Solve different mathematical problems
	Explain concept of basic science related to the field of study

basic science in the field of study. (PSS/N9402)	
SECOND YEAR	
16. Set (both job and tool) CNC turn centre and milling machine to produce simple components as per drawing (TSC/N5702, TSC/N9015)	Operation of CNC machine in different Modes [JOG, MPG, MDI, EDIT, AUTO].
	Operation of CNC machine using G codes and M codes, Measure offset –Work and Tool Offset for Turning and Milling.
	Tool Path simulation for Turning and Milling.
	Working on tool handling and work handling:-Methods of mounting Tool and work –use of cutting tool as per material and tool cutter compensation.
	Program Preparation and Practice on Plain, step and taper turning, Face Milling and Step Milling.
	Check for dimensional accuracy of job using appropriate gauges and measuring instruments.
17. Construct simple pneumatic control system to measure various parameters using transducer, sensor and switches. *[Various parameter: pressure, flow, level of oil, load displacement]* *(*TSC/N9015)	Plan and identify tools, instruments and equipment for the work and make it available timely.
	Set up workplace/ assembly location with due consideration to operational stipulation.
	Plan work in compliance with standard safety norms and collecting desired information.
	Construct pneumatic control system as per design/ application requirement.
	Measure various parameters as per the set up.
	Record data as per standard format/ designed chart.
18. Check various components of pneumatics system and construct pneumatic circuit to check functionality. *(*TSC/N9015)	Identify various components of pneumatic system and check their functionality.
	Plan and identify tools, instruments and equipment for the work and make it available timely.
	Set up workplace/ assembly location with due consideration to operational stipulation.
	Plan work in compliance with standard safety norms and collecting desired information.
	Construct pneumatic circuits and check their functionality.
19. Construct an electro-pneumatic circuit and check functionality of a process. *[E.g.-process:*	Plan and identify tools, instruments and equipment for the work and make it available timely.
	Set up workplace/ assembly location with due consideration to operational stipulation.

Automatic braking system.] (ELE/N9489)	Plan work in compliance with standard safety norms and collecting desired information.
	Construct electro-pneumatic circuit as per design/ application requirement.
	Check the functioning of processes as per desired requirement.
20. Install an electro-pneumatic system and trouble shoot faults. (ELE/N9489)	Plan and identify tools, instruments and equipment for the work and make it available timely.
	Set up workplace/ assembly location with due consideration to operational stipulation.
	Plan work in compliance with standard safety norms and collecting desired information.
	Construct and Install electro-pneumatic system as per design/ application requirement.
	Check the functioning of system as per desired requirement.
	Troubleshoot the faults during functioning.
21. Construct simple hydraulic circuit and check functionality. (CSC/N9488)	Plan and identify tools, instruments and equipment for the work and make it available timely.
	Set up workplace/ assembly location with due consideration to operational stipulation.
	Plan work in compliance with standard safety norms and collecting desired information.
	Construct simple hydraulic circuit as per design/ application requirement.
	Check the functionality of the circuit.
22. Demonstrate installation of accessories in hydraulic system and troubleshoot defects. (CSC/N9468)	Plan and identify tools, instruments and equipment for the work and make it available timely.
	Set up workplace/ assembly location with due consideration to operational stipulation.
	Plan work in compliance with standard safety norms and collecting desired information.
	Demonstrate the possible solution and agree tasks within the team.
	Install accessories in hydraulic system as per design/ application requirement.
	Check the functioning of system as per desired requirement.
	Troubleshoot the faults during functioning.
23. Construct hydraulic circuits; verify various processes to assess	Plan and identify tools, instruments and equipment for the work and make it available timely.
	Set up workplace/ assembly location with due consideration to

functioning of valves and auxiliaries. *[Various processes:- speed control, flow control, lub system, press control etc.]* (ELE/N9426)	operational stipulation.
	Plan work in compliance with standard safety norms and collecting desired information.
	Construct hydraulic circuit as per design/ application requirement.
	Verify processes to ascertain functioning of valves and auxiliaries.
24. Install hydraulic pump, motors and carryout maintenance of these components. *(*TSC/N5702, TSC/N5703, TSC/9015)	Plan and identify tools, instruments and equipment for the work and make it available timely.
	Set up workplace/ assembly location with due consideration to operational stipulation.
	Plan work in compliance with standard safety norms and collecting desired information.
	Install hydraulic pump & motors as per design/ application requirement.
	Check the functioning of system as per desired requirement.
	Carryout maintenance of these components during non-functioning.
25. Construct different hydraulic system and operate to achieve desired functions. *[Different hydraulic system: - Clamp control, injection control, reciprocating screw, oil filtration, hydraulic press control, accumulator control.]* (ELE/N9489)	Plan and identify tools, instruments and equipment for the work and make it available timely.
	Set up workplace/ assembly location with due consideration to operational stipulation.
	Plan work in compliance with standard safety norms and collecting desired information.
	Demonstrate the possible solution and agree tasks within the team.
	Construct hydraulic system as per design/ application requirement.
	Operate to verify functioning of hydraulic system.
26. Programme PLC and interface with other devices to check its Applications. (ELE/N9490)	Programme a PLC as per application requirement.
	Interface PLC with other devices observing standard procedure and safety.
	Check the functionality of device as per programme.
27. Explain robot anatomy and perform programming robot using teach box, software. (ELE/N7118)	Explain anatomy of robot.
	Collect relevant information to programme robot via teach box, software.
	Programme robot via teach box, software.
	Test functionality.
28. Simulate the electrical	Develop electrical circuit as per desired application.

circuits on simulation software and detect fault as per diagnostic procedure for Electrical system design. **(**CSC/N9473)	Assemble and test Electrical Circuit on simulation software.
	Detect fault observing diagnostic procedure and rectify using simulation software.
	Rectify by resetting errors using simulation software.
29. Simulate the electronic circuits on simulation software and detect fault as per diagnostic procedure for Electronics system design. (ELE/N7110)	Develop electronic circuit as per desired application.
	Assemble and test Electronic Circuit on simulation software.
	Detect fault observing diagnostic procedure and rectify using simulation software.
	Rectify by resetting errors using simulation software.
30. Simulate the Hydraulic and Pneumatic circuit on simulation software and detect fault as per diagnostic procedure for Hydraulics and Pneumatics system design. (ELE/N7109)	Develop Hydraulic and Pneumatic circuit as per desired application.
	Assemble and test Hydraulic and Pneumatic circuit on simulation software.
	Detect fault observing diagnostic procedure and rectify using simulation software.
	Rectify by resetting errors using simulation software.
31. Perform project work on Mechatronics (*Project- "Pick and Place Mechatronics system" involving Fitting, Drilling, Turning, Milling, Grinding, Electrical wiring, programming, Hydraulic circuit assembly, Pneumatic circuit assembly, Drives, system assembly and Interfacing, functional testing, trouble shooting and repair. Safety measures in each stage*) (CSC/N0304)	Manufacture and assemble Mechanical sub system.
	Prepare Pneumatic circuit and interface.
	Prepare Electrical/Electronic circuit and interface.
	Develop and download PLC program.
	Integrate, Test and Repair for functionality.
32. Read and apply engineering drawing for	Read & interpret the information on drawings and apply in executing practical work.

different application in the field of work. (PSS/N9401)	Read &analyze the specification to ascertain the material requirement, tools and assembly/maintenance parameters.
	Encounter drawings with missing/unspecified key information and make own calculations to fill in missing dimension/parameters to carry out the work.
33. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. (PSS/N9402)	Solve different mathematical problems
	Explain concept of basic science related to the field of study

7. TRADE SYLLABUS

SYLLABUS FOR TECHNICIAN MECHATRONICS TRADE			
FIRST YEAR			
Duration	**Reference Learning Outcome**	**Professional Skills (Trade Practical)**	**Professional Knowledge (Trade Theory)**
Professional Skill 120Hrs; Professional Knowledge 20 Hrs	Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check for dimensional accuracy following safety precautions. *[Basic fitting operation – Filing, Marking, Hack sawing, Drilling, Taping, chipping and Grinding etc. Accuracy: ± 0.1mm]*	1. Introduction of trade skill and work application. 2. Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). 3. First Aid Method and basic training. 4. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. 5. Hazard identification and avoidance. 6. Identification of safety signs for Danger, Warning, caution & personal safety message. 7. Preventive measures for electrical accidents & steps to be taken in such accidents. 8. Use of Fire extinguishers. 9. Practice and understand precautions to be followed while working in fitting jobs. 10. Importance of trade training, List of tools & Machinery used in the trade. 11. Safe use of tools and equipments used in the trade. 12. Practice memory training and games.	All necessary guidance to be provided to the new comers to become familiar with the working of Industrial Training Institute system including stores procedures. Safe working practices 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.

		13. Workshop on Motivation. (by experts). 14. 5S training.	
		15. Identification of tools &equipments as per desired specifications for filing and marking, visual inspection of raw material for rusting, scaling, corrosion etc. 16. Familiarization of bench vice. 17. Filing- File top of the "U" channel, check and measure with steel rule. 18. Mark with scriber and steel rule 19. Familiarization of Vernier Height Gauge. 20. Measuring practice with steel rule,Vernier Height Gauge.	Bench work – Metal working hand tools and devices –Work bench – vices – files – hacksaw – hammer – chisels – spanners – screw drivers – scrapers. Linear measurements- its units, steel rule dividers, callipers – types and uses, Punch – types and uses. Description, use and care of marking table. Vernier caliper – its parts, principles, reading, uses and care.
		21. File, mark straight and parallel lines with scriber and steel rule/Vernier Height Gauge as per drawing. 22. Dot punching and letter and number punching. 23. File "U" channel to size andby using straight edge, try-square and vernier calliper measure and check-Accuracy +/-0.1mm. *(Note down all dimensions and submit to instructor for verification)* 24. Sawing different types of metals of different sections-round piece and Angle Iron. 25. Prepare mushroom head on round bar by hammering.	Outside micrometer – its parts, principles, reading, uses and care, vernier height gauge. Marking tools – scriber, Dividers, Dot punch, Centre punch. Marking out – Coordinates system, Rectangular – Polar – Rules for marking Bevel protractor, combination set- their components, uses and cares. Pedestal grinder, star wheel dresser, safety precautions, care and maintenance.
		26. Make "S" bend by Hammering on flat piece.	Marking media, marking blue, Prussian blue, chalk and their

		27. Demonstrate grindingof centre punch, dot punch, flat chisel and scriber. 28. Drill grinding practice. 29. Drill Centring Practice.	special application, description. Surface plate and auxiliary marking equipment, 'V' block, angle plates, parallel block, description, types, uses, accuracy, care and maintenance. Bevel protractor, combination set- their components, uses and cares. Drill, Tap, Die-types & application. Determination of tap drill size. Reamer- material, types (Hand and machine reamer), parts and their uses, determining hole size for reaming, Reaming procedure. 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.
		30. Demonstrate on measuring instruments. 31. Job setting and tool setting on drilling machine. 32. Chain drilling practice. 33. Die passing practice.	Measuring Instruments – purpose –Function- types – Calculation of Least count of :- Vernier Caliper, Micro meter, height gauge, Vernier bevel protector and Sine bar. Drill and Drilling 1) Drill- Purpose– Function- types and tool Geometry, Nomenclature, Control Angle and Tool Life. 2) Reamers -Purpose –types. 3) Hand Tap and Die- Purpose–

			types. 4) Drilling Machine - Constructional features-working principle-Purpose- functions, Types - Accessories and uses.
Professional Skill 45Hrs; Professional Knowledge 10 Hrs	Perform different fit of components for assembling as per required tolerance observing principle of interchange ability and check for functionality. [Different Fit –Open & Square Fit; Required tolerance: ±0.05 mm]	34. Make Male & Female 'Open' fitting with accuracy ±0.05 mm. 35. Make Male & Female 'Square' fitting with accuracy ±0.05 mm. 36. Perform scraping practice.	Introduction about metals, difference between Metal and Non Metal, properties of metal, Classification of metals and its applications, pig – iron, cast iron, wrought iron, steel-plain carbon steel(Low carbon steel, medium and high carbon steels, high speed steel, stainless steel, carbides, etc..) Limit and Fits – Limit, Fits -Types and Tolerances and allowances with IS 919 *Interpretation of ISO system of limits and fits.*
Professional Skill 160Hrs; Professional Knowledge 25 Hrs	Produce components involving different operations on Lathe, Milling and Grinding machines observing standard procedure and check for accuracy. *(Different Operations –facing, plain turning, step turning, parting, chamfering, shoulder turn, grooving, knurling, threading (external 'V' only), plain milling, step milling, grooving, slot milling, profile milling, surface grinding and cylindrical grinding (internal and external)*	37. Identify different parts of lathe and demonstrate the operation of the machine. 38. Job setting and tool setting. 39. Perform Facing and Centre drilling. 40. Demonstrate Plain turning between centres and chamfering. 41. Step turning and Shoulder turning.	Lathe Machine - Constructional features, Specification -working principle-Purpose - functions - Types , Lathe machine elements and uses of accessories Lathe mechanism -Function and importance of –Driving mechanism-Gear Box mechanism.
		42. Taper turning (compound rest). 43. Grind single point cutting tool (Straight, Left and Right) 44. Plain turning in a chuck and Drilling practice.	Lathe cutting tool - Purpose– function-types, tool elements and its applications and Cutting tool, geometry, Nomenclature, Control Angle and Tool Life. Lathe Operations- Facing, plain turning, Step turning, chamfering, tapper Turing and calculations, knurling, boring and step boring, Die passing. Cutting speed, Feed, depth of cut and time calculations.

		45. Knurling practice. 46. Making a bolt and nut using external and internal thread cutting on Lathe. 47. Taper measurement using Sine bar / Sine centre.	Pedestal Grinding Machine-Constructional features-working principle-Purpose-function – uses and applications.
		48. Identify different parts of milling machine and demonstrate the operation of the machine. 49. Milling a parallel block. 50. Step milling. 51. Making a T-nut (milling, drilling and tapping).	Milling Machine - Constructional features-working principle-Purpose- functions, Types and uses of accessories. Milling Operations- methods of milling, Plain milling, Step milling, end milling, machine time calculation.
		52. Making one “V” block consists of plain milling, groove milling, taper milling and slot milling.	Milling Cutter- Purpose– types, Cutting tool Geometry, Nomenclature, Tool Life.
		53. Pocket opening milling and matching (male and female). 54. Straddle milling for making hexagonal head. 55. Milling profiles and matching.	Selection of coolants / cutting fluids for different materials. Cutting speed, Feed, depth of cut and time calculations. Fasteners: - Types- purpose and its Application. (03hrs)
		56. Identify different parts of Surface Grinding Machine and demonstrate the operation of the machine. 57. Grinding a parallel blocks. 58. Step grinding using surface grinding.	Grinding-Surface grinding machine-Constructional features-working principle-Purpose -functions, types, machine elements and uses of accessories, machine calculation and method of Surface Grinding operations. Cylindrical grinding machine-Constructional features-working principle-Purpose- functions-Types, machine elements and uses of accessories, machining calculations and Method of Cylindrical Grinding operations.
		59. Identify different parts of Cylindrical Grinding	Grinding Wheel- specification – Grit-Grain size-Structure-Bond-

		Machine and demonstrate the operation of the machine. 60. External plain cylindrical grinding. 61. Step cylindrical grinding. 62. Internal cylindrical grinding.	Grades and selection of Grinding wheel - Dressing –Truing and balancing of Grinding wheel.
Professional Skill 45Hrs; Professional Knowledge 10 Hrs	Perform different computer operation and trouble shoot. [Different computer operations: setting of computer & MS Office operation]	**Basic Computer Operations** 63. Draw sketches using paint for practice on mouse/touch pad. 64. Create, save, rename, move, copy and delete files and folders. Transfer files and folders from/to external storage devices, Create zip file, Extract the zip file, Create automatic backup, Hide/unhide files/folders, Create password for individual files. Change the display properties for Back ground, Resolution, Screen saver, Desktop icons, Gadgets. 65. Settings of the control panel for Add/remove hardware, Install/uninstall software, Change properties of peripheral devices, Connecting Projector. **MS-Office** 65. Work on different menus and editing options of MS-Word. 66. Create your resume in MS-Word. 67. Create purchase order using tables and images. 68. Create an invitation letter using mail merge for 'n' invitees. 69. Workon different menus	Basic blocks of a computer, Components of desktop and motherboard. Hardware and software, I/O devices, and their working. Different types of printers, HDD, DVD. Various ports in the computer. Windows OS MS widows: Starting windows and its operation, file management using explorer, Display & sound properties, screen savers, font management, installation of program, setting and using of control panel, application of accessories, various IT tools and applications. Concept of word processing,: MS word – Menu bar, standard tool bar, editing, formatting, printing of document etc. **Word Processing Software** • Introduction to the various applications in MS office. • Introduction to Word features, Office button, toolbars. • Creating, saving and formatting and printing documents using Word. • Working with objects, macro, mail merge,

		and formulae options of Excel. 70. Create mark sheet and chart using spread sheet with data validation. **Basic Trouble Shooting PC** 71. Check PC Power Supply, SMPS cables and connections to the mother board, connection of I/O devices to PC, HDD/DVD cables. 72. Remove and reinsert CMOS battery, RAM, Connect SATA/IDE Cables to Hard Disk Drive, peripherals (Keyboard, Mouse, USB drive, printer), SVGA/HDMI Cable to the system, Multimedia devices to AV port, Crimp CAT 6 cable to RJ 45 connector.	templates and other tools in Word. **Excel –** Worksheet basics, data entry and formulae. Moving data in worksheet using tool bars and menu bars, Formatting and calculations, printing worksheet, creating multiple work sheets, creating charts.
Professional Skill 45 Hrs; Professional Knowledge 10Hrs	Perform joining of metals by welding and brazing observing standard procedure.	66. Identify different parts of gas welding / arc welding / MIG welding equipment and demonstrate their functioning. 67. Simple welding and brazing practice. 68. Work on tray brazing, die welding, welding on hardened die block.	Explanation of gas welding, arc welding and MIG welding techniques description of welding equipments and welding joints. Knowledge about flux, filler rod material. Die welding techniques.
Professional Skill 80Hrs; Professional Knowledge 15 Hrs	Construct different electrical sub-systems and measure parameters. [Different electrical sub-systems: - AC/DC Motors, DC machine, DC motors, DC motor starter, Universal motor, Induction motor, AC drive,	69. Measures to rescue a person from live wires. 70. Perform exercise to find out relationship between V, I, R and analyse the effect of short and open circuit in a circuit. 71. Check/Test the line, neutral and earth wires before connecting cable in to plugs. 72. Demonstrate the given	**<u>Basic Electrical Engineering</u>** Concept of current, voltage, resistance, electric charge, current density and Power and energy. Ohms law and Kirchhoff's Laws. Primary and secondary cells. Measurement of voltage and current in Net works. AC parameters for sine and Square wave forms. **Electromagnetic theory: -** Flux,

	Servo drive, transformer.]	Electrical circuit/board familiarization with different types of plugs, sockets, switches, fuses and fuse holder. 73. Construct different DC sources by serial and parallel connection of batteries. 74. Ascertain different electrical instruments as per the drawings. 75. Measure the voltage and current in AC/DC Circuits using ammeter, voltmeter, and multi meter. 76. Measure power factor in poly-phase circuit using ammeter, voltmeter and wattmeter readings. 77. Construct series and parallel combination circuits and verify them. 78. Construct a simple circuit to test the operation of a Relay. 79. Measure input and output voltages in stabilizers, power supply unit in the control panel. 80. Application of test lamp and multi meter for identifying single and three phase supply. 81. Physical identification of Mechanical parts and winding details of AC/DC Motors. 82. Develop work plan to test DC Machine winding continuity and insulation resistance. 83. Construct and perform	Flux density, magnetic effect, magnetic field, electromagnetic force, concepts of coil (electromagnetic). Solenoids and relays. **Instrument used for Measuring electrical parameters:-** Measurements of electrical quantities using voltmeter , Ammeter, Multimeter, Megger. Power supply units and Stabilizers. Electromagnetic induction, Motor and Generator effect. Types of AC and DC Motors, Construction and its working principles, Speed control of AC/DC Motors. Principle and Operation of servo motor, Stepper motor and its applications. Concepts of AC/DC Drives. Principle and operation of single phase, Three phase transformer and Auto transformer. Winding details of three phase transformer. Tacho Generator. Instrument transformers (CT and PT), clamp meter, Phase sequence meter, Power factor meter. Concepts of open loop and closed loop systems, feedback devices used in Mechatronics, Principle and Operation of tacho-generator, Encoder, and linear scale. (28 hrs)

		forward and Reverse operation of DC Motors. 84. Construct and perform speed control of DC Motors. 85. Connect, start, run and reverse of AC, single phase motor (inductive-start and capacitive-start). 86. Control the speed of AC motor. 87. Connect, Start, Run and reverse universal motor. 88. Selections of accessories of a DOL starter, assemble, and run induction motor. 89. Start, Run and reverse AC 3-phase motor using star-delta starter. 90. Check the Motor speed and its line current using Tacho Generator and Clamp on meter. 91. Configure AC drive for controlling induction motor. 92. Configure DC drive for controlling DC motor. 93. Construct a simple circuit to test positional and velocity control using Servo Drive. 94. Exercise on positional accuracy using encoder. 95. Exercise on positional accuracy using linear scale. 96. Verify the terminals of 3-phase transformer HT and LT side. 97. Measure Voltage and current of 1-Φ, 3-Φ Auto transformer. 98. Measure phase sequence and power factor using phase sequence meter, power factor meter.	

		99. Measure the current of a given load using Tong-Tester.	
Professional Skill 80Hrs; Professional Knowledge 15 Hrs	Construct different electronics sub system and test electronic devices and sub system. *[Different sub system: - Diodes, rectifier circuit, voltage regulator, transistor power electronic devices, op-amp circuit, LED circuit, SCR etc.]*	100. Test the Electronic components using component tester and Multi meter, CRO and Test ICs using IC Tester. 101. Measure AC/DC parameters using CRO. 102. Construct Diode circuit and draw V-I characteristics. (02hrs) 103. Construct and test Half-wave, Full-wave and Bridge rectifier. 104. Construct Transistor Switch. 105. Construct Transistor Amplifier circuit. 106. Construct Zener regulator. 107. Construct transistor voltage regulator circuit. 108. Construct a 12/5 V DC power supply circuit. 109. Construct variable DC Regulated power supply. 110. Construct and verify basic op-amp circuits (Inverting, Non-inverting). 111. Construct comparator and Instrumentation Amplifier using Op-Amp. 112. Construct and Verify Photo LED circuit. 113. Construct and verify the operation of LDR and Photo diode. 114. Construct isolation circuit using opto-isolator. (04hrs) 115. Testing of SCR, DIAC, TRIAC, IGBT and UJT using Multimeter and	**Electronic components:** Basic Electronic components (active and passive) and its symbols. Reading of electronic circuit drawing. Types of Resistors, capacitors and its identification. Working and operation of Diodes. Rectifier circuits. Zener voltage Regulator. Transistors and its applications. CRO-Block diagram and its functions. DC Regulated power supplies. Introduction to Op-Amp, characteristics, Configuration and its applications. Introduction to Opto-electronics, LED, LDR, Photo diode, opto-coupler. **Study of Power Electronic Devices:** Power diodes, power transistors, SCR, DIAC, TRIAC, UJT IGBT, phase control rectifiers, Converters. **Soldering Techniques: -**. Describe Soldering and De-soldering process, Do and Don'ts of soldering. Concepts of SMD.

		component tester. 116. Construct a phase control rectifier circuits using SCRs. 117. Construct and test UJT Relaxation oscillator. 118. Construct and test universal motor speed control by using SCR. 119. Practice Soldering and De-soldering on the PCBs for a given circuit(s).	
Professional Skill 60Hrs; Professional Knowledge 12 Hrs	Estimate and perform panel wiring using cables, connectors, Protective devices and test functionality.	120. Perform Termination of wires, cables and electronic components. 121. Perform Skinning, dressing, and joining for different types of cables. 122. Perform Crimping practice on RJ45, BNC, Audio, D-shell and Edge connectors. 123. Measure Insulation Resistance by using Megger. 124. Perform wiring in PVC conduit for power sockets controlled independently. 125. Perform wiring to control one lamp from different places. 126. Perform wiring to install buzzer, buttons, and protection alarm. 127. Prepare panel mains board with switch and distribution fuse box. 128. Estimate the materials for a given panel board connection plan. 129. Perform Wiring of power and control circuits in the panel board. 130. Measure earth resistance using earth tester.	**Electrical cables and connectors:** Colour code of cables, cable joints (straight joints and T-Joints), wiring layout diagrams, Types of cables and its specifications: co-axial cables, Fiber optical cables. Types of connectors and its specifications: Power connectors, Flat cables, RJ45 Connector, BNC, TNC, Audio Video, D-Shell and Edge connector. Cable termination methods, cable layout diagrams, electrical control panel wiring and electrical bus systems. Purpose of using protective devices, Fuses, Contactor ,Relays, Timers, Circuit Breakers, MCBs, ELCBs, DOL ,Star – Delta Starters, Push buttons, Limit switches, Micro switches, Float switches, Solenoids, Float switch, OLRs, Photo electric relay, Importance of earthing, Types of earthing techniques. Importance on electrical safety, safety marking and symbols, Risk management, Electric hazards, Prevention of accidents and Personal safety aspects.

		131. Test the switches, pushbuttons, limit switches, Foot pedal switch, Micro switches for its operation 132. Practice on working of protective elements such as MCB, OLR, ELCBs and fuses in power circuits. 133. Ascertain different safety symbols and signs used in workshop.	Environment safety and safety precautions while handling electrical equipments. Classification of fires, Different type of firefighting equipment. (12hrs)
Professional Skill 45Hrs; Professional Knowledge 10 Hrs	Construct and verify different Digital Logic Circuits. (Different DLC:- Logic Gates, half & full adder, binary & outer, P/down counter).	134. Verify the truth table of AND, OR, NOT, NAND, NOR, XOR gates. 135. Construct and verify SR, JK, T and D Flip-Flops. 136. Construct and verify Binary counter, UP/DOWN counter circuits. 137. Construct and verify encoder and decoder circuits. 138. Construct Multiplexer and De multiplexer circuits. 139. Construct on Analog to Digital Converter (R-2R). 140. Digital to Analog converter *(Comparator, Dual slope, Successive approximation.)*	**Number System:** Binary, Decimal, Octal, Hexa Decimal Number systems and its Conversions. Binary Arithmetic and logical operations. **Digital Logic:** Boolean algebra. Logic gates: AND, OR, NOT, NAND, NOR, XOR. Encoder and Decoders. Concepts of Flip-Flop: SR, JK,T, D. Counters, Multiplexers and De-Multiplexers. Memories: Discs, RAM, ROM, Semiconductor memories.
Professional Skill 25Hrs; Professional Knowledge 07 Hrs	Install different software in computer system and test. *[Different software: Office, Multimedia, Fluidism, PLC, etc.]*	**Software Installation** 141. Prepare Hard disk for OS installation by making partitions. 142. Setup CMOS with desired parameters for hard disk and set date and time. 143. Install Operating System Windows and Linux in two different partitions. 144. Install Device Drivers(Printers, Scanners, Xerox, audio),	Distinguish between System Software and Application Software. Differentiate between Linux and Windows OS Windows 32 bit, and 64 bit System FDISK, Format, Scandisk, FAT System, NTFS and Directories, Fragmentation and defragmentation disk Familiarisation of MS-office or equivalent tools for creating

		Install/Uninstall Application software (Office, Multimedia, Fluidsim, PLC and other simulation software) 145. Perform IT-supported fault diagnostics on systems and sub-systems within automation systems, identify, assign and check functions and components.	documents, spread sheet and presentation Explain and apply common prevention methods, Explain Service Flow Sequence (SFS) and Trouble Shooting Chart (TSC) of PC. Concept and need of – Digitalization – Concept of Industry 4.0 Introduction, working and Applications of – RFID (Identification, system and application) – Bus (Binary unit system) Control – Information Security – GPS services
Professional Skill 45Hrs; Professional Knowledge 10 Hrs	Write an assembly level programme and interface peripherals to 8051 Microcontroller to check functioning.	146. Physically identify the components in 8051 trainer kit. 147. Write an program to perform arithmetic operations. 148. Write a program to perform exchange the memory location contents. 149. Interface LEDs to microcontroller and develop different patterns on it. 150. Interface switches and LEDs with microcontroller. 151. Interface buzzer to microcontroller. 152. Interface DC motor with microcontroller. 153. Interface stepper motor control with microcontroller.	Basic block diagram of computer system. Block diagram of Microprocessor and its functionality. Difference between Microprocessor and Microcontroller. 8051 Microcontroller-features, Block diagram and pin configuration. Assembler directives, Instruction set of 8051.Assembly language Programming.
Professional Skill 45Hrs;	Troubleshoot and repair different Electrical, Electronic	154. Replacement of fuses, Locating OLR and its resetting practice.	Introduction to maintenance, Importance of maintenance and types.

Professional Knowledge 10 Hrs	systems/ devices. *[Different Electrical, Electronic systems/ devices:- Fuse, MCB, Power circuit, Control panel, Circuit Breaker, Stabilizer, AC/DC drives.]*	155. Locating faults in power circuit such as fuse blown, MCB Tripped, control fuse blown etc. 156. General checking of loose contacts in the control panel wirings. 157. Troubleshoot and Service a circuit breaker. 158. Service and troubleshoot the DC motor starter. 159. Maintain, Service, and troubleshoot DC Machine. 160. Identify controls, trace the circuit and test the function of stabilizer. 161. Trouble shoot and maintenance of UPS and stabilizer. 162. Trouble shooting of AC/DC Drives. Check the feedback sensors.	Guidelines for trouble shooting of electrical, electronic systems and PLC.
Professional Skill 45Hrs; Professional Knowledge 10 Hrs	Demonstrate function of different sensors. *[Different sensors: Proximity Sensors, inductive sensor, capacitive sensor, magnetic sensor, Reflex Photoelectric Sensors, Temperature Sensors, etc.]*	163. Behaviour of Proximity Sensors, inductive sensor, capacitive sensor, magnetic sensor. 164. Construct simple control circuit using Proximity sensor and reed switch and limit switch. 165. Identify Behaviour of Reflex Photoelectric Sensors. 166. Identify Behaviour of ultrasonic sensor. 167. Identify Behaviour of reed switch and limit switch. 168. Identify Behaviour of Temperature Sensors. 169. Identify Behaviour of Level Control. 170. Logical operation of sensors	Introduction to Sensors & transducers Sensors - Classifications & Operation Proximity Sensor -Classifications & Operation Sensors for Temperature measurements Sensors for Distance and Displacement Sensor characteristics and interface technique.

		171. Interface Sensors and Electrical Actuators. 172. Interface Sensors and Pneumatic Actuators.	
Engineering Drawing: 40 hrs.			
Professional Knowledge ED- 40 Hrs.	Read and apply engineering drawing for different application in the field of work.	**<u>Engineering Drawing:</u>** Introduction to Engineering Drawing and Drawing Instruments – • Conventions • Sizes and layout of drawing sheets • Title Block, its position and content • Drawing Instrument Lines- Types and applications in drawing Free hand drawing of – • Geometrical figures and blocks with dimension • Transferring measurement from the given object to the freehand sketches. • Free hand drawing of hand tools and measuring tools. Drawing of Geometrical figures: • Angle, Triangle, Circle, Rectangle, Square, Parallelogram. • Lettering & Numbering–Single Stroke. Dimensioning • Types of arrow head • Leader line with text • Position of dimensioning (Unidirectional, Aligned) Symbolic representation– • Different symbols used in the related trades. Concept and reading of Drawing in • Concept of axes plane and quadrant • Concept of Orthographic and Isometric projections • Method of first angle and third angle projections (definition and difference) Reading of Job drawing of related trades.	
Workshop Calculation & Science: 36 Hrs.			
Professional Knowledge WCS- 36 Hrs.	Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	**Unit, Fractions** • Classification of unit system • Fundamental and Derived units F.P.S, C.G.S, M.K.S and SI units • Measurement units and conversion • Factors, HCF, LCM and problems • Fractions - Addition, substraction, multiplication & division • Decimal fractions - Addition, subtraction, multilipication & division • Solving problems by using calculator	

		Square root, Ratio and Proportions, Percentage • Square and suare root • Simple problems using calculator • Applications of pythagoras theorem and related problems • Ratio and proportion • Ratio and proportion - Direct and indirect proportions • Percentage • Precentage - Changing percentage to decimal and fraction **Material Science** • Types metals, types of ferrous and non ferrous metals • Introduction of iron and cast iron **Mass, Weight, Volume and Density** • Specific gravity **Speed and Velocity, Work, Power and Energy** • Speed and velocity - Rest, motion, speed, velocity, difference between speed and velocity, acceleration and retardation • Speed and velocity - Related problems on speed & velocity • Work, power, energy, HP, IHP, BHP and efficiency **Heat & Temperature and Pressure** • Concept of heat and temperature, effects of heat, difference between heat and temperature, boiling point & melting point of different metals and non-metals • Scales of temperature, celsius, fahrenheit, kelvin and conversion between scales oftemperature **Basic Electricity** • Introduction and uses of electricity, molecule, atom, how electricity is produced, electric current AC,DC their comparison, voltage, resistance and their units • Conductor, insulator, types of connections - series and parallel • Ohm's law, relation between V.I.R & related problems • Electrical power, energy and their units, calculation with assignments • Magnetic induction, self and mutual inductance and EMF generation • Electrical power, HP, energy and units of electrical energy **Trigonometry** • Measurement of angles • Trigonometrical ratios
Industrial Training **Conveyor Control System (This can be used for Second Year project.)**		

SYLLABUS FOR TECHNICIAN MECHATRONICS TRADE			
SECOND YEAR			
Duration	**Reference Learning Outcome**	**Professional Skills (Trade Practical)**	**Professional Knowledge (Trade Theory)**
Professional Skill 90Hrs; Professional Knowledge 27 Hrs	Set (both job and tool) CNC turn centre and milling machine to produce simple components as per drawing.	172. The Modes of Operation On the machine JOG, MDI, REF, MPG, EDIT on CNC turning and Milling 173. Perform on co –ordinate systems, use of CNC codes	Introduction to NC /CNC Technology, Importance and applications in industry. Difference among NC, CNC and FMS (Flexible Manufacturing System). Working principle and Construction details of CNC System-Functional Block Diagram and its Features-Measuring /Feedback System. Main Elements of CNC machine (Turning/Milling)-CNC Control Panel-feedback devices-encoders.
		174. Tool Path practice in Absolute and Incremental Coordinate system. 175. Perform On - Zero and Tool Offset and record of offset parameters in System.	Introduction to coordinate System, Axes Designation – CNC Codes-G and M (Siemens and Fanuc control) –calculation of Spindle speed, feed, depth of Cut. Modes of operation of CNC machine.
		176. Selection of Cutting speed, Feed, Depth of cut for CNC turning operations. 177. Perform on Changing of tool holder and tool Inserts on CNC lathe. 178. Facing and plain turning. 179. Produce a component using CNC turning centre.	Absolute and Incremental coordinate system. Procedure for simulating tool path program. Offsets, types of offsets and importance of offset for work and tool. Procedure for setting offset and recording offset parameters in CNC system.
		180. Selection of cutting speed, feed, depth of cut for CNC milling operations. 181. Perform on Changing of tool holder and tool Inserts on CNC Milling machine. 182. Program preparation for step milling and contour	Calculations: Cutting speed, Feed, Depth of cut and machining time calculations. Tools and Tool holders for turning operations and milling operations. Simple programming for

		milling. 183. Produce a component using CNC milling centre with multiple operations.	facing, plain turning, step turning operations and milling operations.
Professional Skill 25 Hrs; Professional Knowledge 08 Hrs	Construct simple pneumatic control system to measure various parameters using transducer, sensor and switches. *[Various parameter: pressure, flow, level of oil, load displacement]*	184. Measure the level of oil using level switch (Magnetic Level) 185. Measurement of Load using Load cell. 186. Measurement of Displacement using LVDT. 187. Construct an open loop control system for pressure, temperature, flow and level. 188. Construct closed loop control system for pressure, temperature, flow and level.	• Definition and history of Pneumatic. Pneumatic system: i. Basic components ii. Comparison to pneumatic systems. iii. Advantages and limitations. iv. Application of pneumatics. • Compressible fluids - types, properties of air, applicable gas laws (Boyle's, Charles', Gay-Lussac' laws). • ISO symbols used in pneumatic circuits • Transducer, Types and Classification, Principle and operation of Temperature, Pressure, Flow, Level. • Process transmitter for temperature, magnetic, pressure, flow and Level. • Process Controller – PI&D Concept. • Function and applications of LVDT, Ultrasonic sensors, Load cell, Micro switch, Float switch, Proximity sensor, Limit Switch. • Functional plan and application of sorting Transmission, multiple Sensors in Automation System.
Professional Skill 45Hrs; Professional Knowledge 14 Hrs	Check various components of pneumatics system and construct pneumatic circuit to check functionality.	189. Use logic valves and construct in pneumatic circuit. 190. Construct and perform the operation of Pressure control valves.	Types, constructions, designations, working, applications and selection criteria of following: i. Directional control valves. ii. Flow control valves.

		191. Using Time Delay valves perform the operation of pneumatic actuator. 192. Perform on Hydraulic and Pneumatic Simulation software. 193. Prepare a Specification for various pneumatic elements (actuators, motors, valves and cylinders) of Lab/ workshop.	iii. Pressure control valves. iv. Special valves- quick exhaust valve and time delay valve. v. Logic valves- shuttle valve and twin pressure valve. Other fittings and access of Simulation Software for construction of Pneumatic circuits. Types of pneumatic fitting and their selections. Construction of pneumatic circuits using simulation software. Pneumatic cylinders- types, construction, working, materials, specifications, mounting and cushioning. Pneumatic motors- types, construction, working, specifications and applications. Referring machine manual and manufacturer's catalogue.
Professional Skill 25 Hrs; Professional Knowledge 08 Hrs	Construct an electro-pneumatic circuit and check functionality of a process. *[E.g.- process: Automatic braking system.]*	194. Construct an electro pneumatic circuit for Automatic Brake system. (i) Preparation of Specification and selection criteria of pneumatic elements. (ii) Construction of pneumatic circuit and assembly of elements as per the drawing. (iii) Interfacing of Pneumatic I/O s with PLC (iv) Checking of functionality of pneumatic brake system 195. Prepare a chart with ISO symbols and guiding rules for designing pneumatic	• Pneumatic devices – concept and Importance. • Pneumatic Drives –I/P converter and P/I converter. Electro-pneumatic circuits: i. Reciprocation of cylinder using pressure switches. ii. Control of a cylinder using a single limit switch. iii. Automatic dual cylinder sequencing circuits. iv. Pressure dependent control of a double acting cylinder. Construction, working principle, major elements, performance variables and applications of following devices:

		system.	i. Automotive pneumatic brake. ii. Automotive air suspension. iii. Pneumatic drill. iv. Pneumatic gun (tools).
Professional Skill 45Hrs; Professional Knowledge 14 Hrs	Install an electro-pneumatic system and trouble shoot faults.	196. Install and electro-pneumatic system a. Identify the parts of a two stage air compressor. b. Check oil level, Grade and adjustment of pressure in pressure switch. c. Air filter cleaning and replacement , Replacement of piston ring d. Gasket Checking and replacement e. Check the cooling system of air compressor f. Check and draw electrical power supply of compressor. 197. Install the FRL unit and check and adjusting the setting of pressure in pneumatics lines. 198. Conduct bearing maintenance. 199. Construct and Install an electro Pneumatic Pick and Place system, identify the various faults in the system and the remedial actions for them. 200. Construct and Install an electro Pneumatic conveyor belt with sorting Mechanism system, identify the various faults in the system and the remedial actions for them.	• Basic of pneumatic elements and system. • Types, construction, working, specifications and selection criteria of following air preparation and conditioning elements: i. Air compressors ii. Air receivers' iii. Air dryers iv. Air filters, regulators and lubricators (FRL unit). Bearing and its functions Lubrication and their selections. • Installation of pneumatic systems. • Causes, remedies and Troubleshooting in pneumatic elements. • Maintenance of pneumatic systems: i. Maintenance schedule and Inspection Check Sheet preparation ii. Maintenance of different application of Pneumatic system.
Professional Skill 25 Hrs;	Construct simple hydraulic circuit and check functionality.	201. Check of pressure built up and setting relief valve pressure in hydraulic system	Introduction and Definitions of important terms like Hydraulics, Pressure, Force,

Professional Knowledge 08Hrs		and checking of Line filter. 202. Tabulate the selection criteria of different grades of Hydraulic oil for the system. 203. Construct simple hydraulic circuit • Pressure Regulating Circuit • Safety Circuit • Dual Pressure Regulating Circuit • Sequence Control Circuit • Pressure Counterbalancing Circuit • Pressure Reducing Circuit • Meter-In Flow Control Circuit • Meter-Out Flow Control Circuit • Bleed-Off Control Circuit • Pressure Keeping Circuit • Differential Circuit • Synchronizing Circuit • Accumulator Control Circuit • Hydraulic Motor Control Circuit 204. Perform on Hydraulic and Pneumatic Simulation software.	Vacuum etc. i. Pascal's Law and its Application of hydraulics ii. Bernoulli's Principle iii. Hydraulic Jacks iv. Hydraulic Symbols and Circuit Building as per Standards DIN/ISO. v. Advantages and Disadvantages of Hydraulic System. vi. Hydraulic Oil and Types. vii. Importance of Hydraulic Oil. viii. Ideal Characteristics of Hydraulic Oil ix. Properties of hydraulic oil e.g. viscosity, ageing stability x. Grades of hydraulic oil xi. Maintenance of Hydraulic Oil xii. Reading, understanding of Hydraulic Symbols for construction of circuit diagrams.
Professional Skill 25 Hrs; Professional Knowledge 08 Hrs	Demonstrate installation of accessories in hydraulic system and trouble shoot defects.	205. Demonstrate Connection of Steel pipes, tubing and hose in Hydraulic line. 206. Installation of Pressure gauge /Indicator along with filter and strainer in Hydraulic system. 207. Fitting of different gaskets and seals in hydraulic line. 208. Installation and troubleshooting of hydraulic power pack.	**Types and Function of Components and Connectors** i) Steel pipe ii) Tubing iii) Hose iv) Gauges v) Packing and Seals vi) Filters and Strainers vii) Hydraulic Tank
Professional Skill 45Hrs;	Construct hydraulic circuit; verify various	209. Construct and perform the operation of Speed control	Construction, Types and working of :

Professional Knowledge 14 Hrs	processes to assess functioning of valves and auxiliaries. *[Various processes: - speed control, lub system, press control etc.]*	of Hydraulic cylinder through Throttle valve. 210. Construct and Perform of Speed control of Hydraulic cylinder through The Flow control valve in Bypass. 211. Construct and verify the functionality of Flow control valve in Meter-in and Meter-out circuit. 212. Construct and control Double acting pneumatic cylinder reciprocation by 3/2 push button valves and Shuttle Valve. 213. Construct and check the function of cartridge valves in Lubrication system. 214. Construct Electro Hydraulic circuit –Speed and Pressure control of double acting cylinder for hydraulic Press. 215. Construct control based hydraulic circuit for operation of double acting cylinder through 5/2 solenoid operated D.C. valve and PLC Controller (Counter based circuit). 216. Perform on Hydraulic and Pneumatic Simulation software	• Directional Control Valves • Pressure Control Valves • Flow Control Valves • Pressure Intensifiers • Accumulators • Cartridge Valves and Cylinder
Professional Skill 25 Hrs; Professional Knowledge 08 Hrs	Install hydraulic pump, motors and carryout maintenance of these components.	217. Demonstrate the different types and working of Pumps using Cut-section Models. 218. Install Hydraulic Pump and Motor and verify its function in hydraulic power pack. 219. Maintenance of Hydraulic Motor and Pump for industry application. i) Preparation of Maintenance Schedule.	**Construction and Working, Specifications :** • Gear Pump • Vane Pump • Radial Piston Pump • Pump Maintenance and Trouble Shooting , Hydraulic Motor Specifications • Construction and Working of

		ii) Preparation of inspection and check sheet.	• Gear Motor • Vane Motor • Radial Piston Motor
Professional Skill 45Hrs; Professional Knowledge 14Hrs	Construct different hydraulic system and operate to achieve desired functions. *[Different hydraulic system:- Clamp control, injection control, reciprocating screw, oil filtration, hydraulic press control, accumulator control.]*	220. Construct and verify One-Cycle Cylinder Reciprocation using limit switches, timer, Pushbutton and Single-Solenoid Valve and double solenoid valve. 221. Construct and perform the operation of Accumulator Control Circuit. 222. Construct and perform the deceleration and Oil filtration Circuit. 223. Construct a hydraulic control circuit for clamping and de-clamping operation of part handling system. 224. Construct and perform the operation of Hydraulic press control using hydraulic elements. 225. Perform on Hydraulic and Pneumatic Simulation software.	Construction of circuits and operation i) Clamp Control Circuit ii) Injection Control Circuit iii) Reciprocating Screw Circuit iv) Oil Filtration Circuit v) Deceleration Circuit vi) Prefill Circuit vii) Hydraulic Motor Circuit viii)Hi-Low Pump Circuit
Professional Skill 75Hrs; Professional Knowledge 20 Hrs	Programme PLC and interface with other devices to check its Applications.	226. Ascertain various modules, controls, and indicators of given PLC. 227. Program and configure the PLC to perform a simple start/stop routine. 228. Program the PLC using Timer and Counter instructions. 229. Program the PLC to perform Move, Arithmetic, and Logical operations. 230. Program the PLC for performing comparator operations. 231. Practice on PLC wiring.	**PLC:** Overview of different control systems. Introduction about PLC. Block diagram of PLC. Different types of PLC, PLC Architectures (Fixed and Modular). Selection of PLC. Advantages of PLC. Applications of PLC. Various types of modules used in PLC. Familiarization of AND, OR and NOT logics with examples. Registers Basics. Timer Functions. Counter Functions. Introduction and importance of Sequential Control Systems. Communication protocols used

		232. Program PLC for controlling analog parameter(s).	in PLC: RS-232, RS-485, Ethernet, Profibus. Different programming languages of PLC: LDR, STL, FBD, CSF. Basic ladder programming of PLC. Configuration of PLC and its modules. Wiring of PLC.
		233. Program a PLC for Traffic Light Control. 234. Program PLC to generate different patterns for a given set of lights. 235. Program a PLC for Reverse Forward Control of a Motor. 236. Program a PLC for Conveyor Belt Motor Control. 237. Program a PLC for parking system of 100 Cars. 238. Program a PLC for motor Star- Delta Control. 239. Program PLC for simple elevator control. 240. Configuration of HMI. 241. Interface I/O with PLC using Profibus system/ Ethernet. 242. Interface PLC to pneumatic and hydraulic circuits. 243. Resetting of major and minor errors in PLC. 244. Troubleshooting of power supply and IO modules in PLC.	Interfacing of PLC with other devices. Safety aspects. Introduction to HMI configuration.
Professional Skill 45Hrs; Professional Knowledge 14 Hrs	Explain robot anatomy and perform programming robot using teach box, software.	245. Identify basic Functions of Teach Box 246. Repositioning of Work pieces using Teach box. 247. Exploring COSIMIR (Programming software)	Anatomy of robots: Overview of a robot manipulator system – basic components of robot, overview of robot applications in industrial automation. Types of end effectors: Grippers and

		248. Simulation - Programming a Work cell and Downloading 249. Prepare teaching Mode in Programming software. 250. Test on Line Mode in Programming software. 251. Test continuous Motion. 252. Perform Palletizing.	tools. Robot Drives & Control, Robot Programming Languages, Robot Application in Manufacturing.
Professional Skill 45Hrs; Professional Knowledge 14 Hrs	Simulate the electrical circuits on simulation software and detect fault as per diagnostic procedure for Electrical system design.	253. Familiarisation with various features and components of Simulation software. 254. Using and Testing of different types of Electrical components using Simulator. 255. Develop Electrical circuit using simulator as per the drawing and test for its functionality. 256. Develop Electrical circuit for any Industrial application using simulator software. 257. Test the Electrical circuit developed in simulator, diagnose the fault, rectification, resetting of errors.	Advantages of Simulator Software. Develop simple Electrical circuit Develop Industrial application based Electrical circuit Trouble shooting techniques and mechanism.
Professional Skill 65 Hrs; Professional Knowledge 18 Hrs	Simulate the electronic circuits on simulation software and detect fault as per diagnostic procedure for Electronics system design.	258. Familiarisation with various features and components of Simulation software. 259. Using and testing of different types of Electronics components using Simulator. 260. Develop Electronics circuit using simulator as per the drawing and test for its functionality. 261. Develop Electronics circuit for any Industrial application using simulator software.	Advantages of Simulator Software. Develop simple Electronics circuit Develop Industrial application based Electronics circuit Trouble shooting techniques and mechanism.

		262. Test the Electronics circuit developed in simulator, diagnose the fault, rectification, resetting of errors.	
Professional Skill 75Hrs; Professional Knowledge 20 Hrs	Simulate the Hydraulic and Pneumatic circuit on simulation software and detect fault as per diagnostic procedure for Hydraulics and Pneumatics system design.	263. Demonstrate Pneumatics fundamentals using simulation software. 264. Demonstrate Electrical control of pneumatic system using simulation software. 265. Demonstrate Hydraulic fundamentals using simulation software. 266. Demonstrate Electrical control of hydraulic system using simulation software. 267. Develop Pneumatic circuit using simulator as per the drawing and test for its functionality. 268. Test the Hydraulic and Pneumatic circuit developed in simulator, diagnose the fault, rectification, resetting of errors.	Advantages of Simulator Software. Develop simple Hydraulic circuit Develop simple pneumatic circuit Troubleshooting techniques and mechanism.
Professional Skill 140Hrs; Professional Knowledge 35 Hrs	Perform project work on Mechatronics (*Project-"Pick and Place Mechatronics system" involving Fitting, Drilling, Turning, Milling, Grinding, Electrical wiring, programming, Hydraulic circuit assembly, Pneumatic circuit assembly, Drives, system assembly and Interfacing, functional*	269. Preparation of mechanical drawing for picks and place project. 270. Preparation of Hydraulic and Pneumatic circuit diagram. 271. Preparation of Electrical wiring diagram. 272. Preparation of Electronics circuit diagram. 273. Prepare bill of material. 274. Perform Filing operation. 275. Perform drilling operation. 276. Perform Turning operation. 277. Perform Milling operation.	Application of Pick and Place project Function of each part Explanation of the drawings (Mechanical, Hydraulic, Pneumatic, Electrical) Assembling Techniques Safety precautions in each stage Testing procedure. Common faults and their rectification.

	testing, trouble shooting and repair. Safety measures in each stage)	278. Perform surface finish operation. 279. Assemble the Mechanical components as per drawing. 280. Assemble Hydraulic and Pneumatic circuit and interface. 281. Assembling and wiring of Electrical and Electronic system integration. 282. Develop, download PLC program and Integrate. 283. Testing, Trouble shooting and Repairing.	
Engineering Drawing: 40 hrs.			
Professional Knowledge ED- 40 Hrs.	Read and apply engineering drawing for different application in the field of work.	• Reading of drawing of nuts, bolt, screw thread, different types of locking devices e.g., Double nut, Castle nut, Pin, etc. • Reading of foundation drawing • Reading of Rivets and rivetted joints, welded joints • Reading of drawing of pipes and pipe joints • Reading of Job Drawing, Sectional View & Assembly view	
Workshop Calculation & Science: 16 hrs.			
Professional Knowledge WCS- 16 Hrs.	Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	**Algebra** • Algebra - Addition, subtraction, multiplication & division • Algebra - Theory of indices, algebraic formula, related problems **Estimation and Costing** • Estimation and costing - Simple estimation of the requirement of material etc., as applicable to the trade • Estimation and costing - Problems on estimation and costing	
Industrial Training / Project work			

SYLLABUS FOR CORE SKILLS
1. Employability Skills (Common for all CTS trades) (120Hrs. + 60Hrs.)

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

ANNEXURE-I

LIST OF TOOLS AND EQUIPMENT			
TECHNICIAN MECHATRONICS (For batch of 24 Candidates)			
Sl. No	**Name of the Tool & Equipments**	**Specification**	**Quantity**
A. TRAINEES TOOL KIT			
1	Steel Rule	150 mm English and Metric combined	24+1 Nos.
2	Engineer's Square	150 mm with knife edge	24+1Nos.
3	Bevel Straight Edge	80 X 100 mm	24+1 Nos.
4	Centre punch	100 mm	24+1 Nos.
5	Dot punch	100 mm	24+1 Nos.
6	File flat bastard	300 mm	24+1 Nos.
7	File flat 2nd cut	250 mm	24+1 Nos.
8	File flat safe edge	200 mm	24+1 Nos.
9	File triangular rough	200 mm	24+1 Nos.
10	Hammer	½ lb ball peen	24+1 Nos.
11	Scriber	6 inch	24+1 Nos.
12	Vernier Caliper	150mm with 0.02 mm least count	24+1 Nos.
13	Micrometer (outside)	0-25 mm	24+1 Nos.
14	Safety goggles (Personal Protective Equipment)		24+1 Nos.
15	Screw driver electrician	150 mm	24+1 Nos.
16	Screw driver	Nos. 860,862	24+1 Nos.
17	Long nose plier	150mm	24+1 Nos.
18	Combination plier	150mm	24+1 Nos.
19	Diagonal cutter	150mm	24+1 Nos.
20	Screw driver Philips	Nos. 860,862	24+1 Nos.
21	Tweezers		24+1 Nos.
22	Knife	100mm	24+1 Nos.
23	Wire Stripper		24+1 Nos.
24	Neon Tester		24+1 Nos.
25	Scissors	150mm	24+1 Nos.
26	Soldering iron	25watts	24+1 Nos.
27	Bread Board		24+1 Nos.
B: TOOLS AND EQUIPMENTS:			
1	Caliper outside	150mm	4 nos.
2	V-block	50 mm X 100mm and 75 mm X 100	2Nos

		mm each	
3	Divider – 150 mm		4 Nos.
4	Screw driver	150 mm and 200mm each	4 Nos.
5	Circlip plier (inside and outside) each		4 Nos.
6	Centre gauge	$55^0$and 60^0	4 Nos.
7	Oil can		4 Nos.
8	Oil Gun and Grease Gun each		4 Nos.
9	File flat smooth	200 mm	4 Nos.
10	File flat smooth	safe edge 200 mm	4 Nos.
11	File half round bastard	300 mm	4 Nos.
12	File half round smooth	250 mm	4 Nos.
13	File triangular smooth	200 mm	4 Nos.
14	File round bastard	250 mm	4 Nos.
15	File square smooth	250 mm	4 Nos.
16	Knife edge file	150 mm	4 Nos.
17	Needle file assorted (12 nos.)	150 mm	4 Nos.
18	File card (spattle)		4 Nos.
19	Scraper flat	250 mm	4 Nos.
20	Hammer Ball Peen	0.5 kg with handle	4 Nos.
21	Hammer Cross Peen	0.75 kg with handle	4 Nos.
22	Chisel cold flat	18 x 150 mm	4 Nos.
23	Chisel Cross Cut	10 x 3 x 200 mm	4 Nos.
24	Chisel Half Round	10 x 250 mm	4 Nos.
25	Chisel diamond point	10 x 200 mm	4 Nos.
26	Scribing block	300 mm	4 Nos.
27	Cast Iron Surface plate	300 x 300 mm	1 No.
28	Granite Surface plate	450 X 450 X 80 mm minimum	1 No.
29	Tap extractor	3 mm to 12 mm x 1.5 mm (ezzy out)	3 set
30	Screw extractor	sizes 1 to 8	3 set
31	Hand Taps and dies	Stock metric 5 mm to 12 mm complete set in a box	2 sets
32	Bench Vice	100 mm jaw	24+1 Nos
33	Machine reamer	set up to 12 mm	2 sets
34	Machine tap set	upto M12mm (with std. pitch)	2 sets
35	Twist Drill	straight Shank Ø 5 to Ø12 mm in steps of 0.5 mm	2 sets
36	Twist Drill	straight Shank Ø 8 mm to Ø 12 mm in steps of 2 mm	2 sets
37	Taper shank drills	Ø 6 mm to Ø 20 mm in steps of 1 mm	2 sets
38	D.E spanners	3-4 , 6-8, 10-12, 13-14, 15-16, 18-19,	2 sets

		20-22, 24-26 (8-spanners)	
39	Letter punch	5 mm set	2 sets
40	Number punch	5 mm set	2 sets
41	Parallel block Standard sets		2 sets
42	Allen key metric	3 to 12 mm set	4 sets
43	Centre drills	3, 4,5 mm	4 each
44	Parallel hand reamer	6 mm to 12 mm in steps of 1 mm with handle	4 sets.
45	Star dresser		1No.
46	Diamond dresser with holder		2Nos
47	Surface gauge		2 Nos.
48	Angle plate-adjustable	250x250x300 mm	2 Nos.
49	Micrometer –inside – outside	depth range up to 75mm each	3 sets
50	Vernier caliper with 0.02mm least count	150mm and 200 mm each	4 Nos.
51	Digital Vernier caliper	150mm and 200mm each	1 No each
52	Digital micrometer (inside, outside and depth)		1 No
53	Height Gauge	300mm with 0.02 mm least count	1 no.
54	Vernier bevel protractor	150 mm blade	1 no.
55	Sine bar and Sine Centre each		1 No each
56	Sprit level		1 No.
57	Slip gauge set (STD)		1 Set
58	Magnetic stand	magnetic base 60 x 47.5 mm and with universal swivel clamp, dial holding rod (150 mm) scriber	2 Nos
59	Dial test indicator	Lever type- Range 0-0.8 mm – Graduation 0.01mm, reading 0-50-0 with accessories	2Nos
60	Dial test indicator	Plunger type-Range 0-10 mm , Graduation 0.01 mm, Reading 0-100 with revolution counter	2 Nos.
61	Bore gauge	dial indicator (1 mm range, 0-0.01 mm graduation)-Range of bore gauge 18-70 mm	1 set
62	Straight edge-Single beveled	Size 150 mm and 250 mm each	1 No
63	Tool maker's clamp	50 mm and 75 mm each	4Nos.
64	C – clamp-	50 mm and 75 mm	4Nos.
65	Bearing Puller	10 mm to 100 mm	2 Nos.
66	Ammeter	0 - 500mA	3Nos.
67	Ammeter	0 – 1 Amp DC	3Nos.
68	Voltmeter	0 – 300/600V AC	4Nos.

69	PF Meter		2 Nos.
70	Phase Sequence Meter		2Nos.
71	Digital multi Meter	2.5 Amps / 5Amps	3Nos.
72	Energy meter, Single / Three phase		2 Nos.
73	Clamp on meter	0 – 50 Amps	2Nos.
74	Ammeter portable type	0 – 15 Amps AC	4Nos.
75	Test lamp		3Nos.
76	Tong-Tester		3Nos.
77	Line Tester		5Nos.
78	Batter Tester		4Nos.
79	Electrician Tool Kit		3Nos.
80	Rechargeable Battery		5 Nos.
81	Pressure Transducers panel board to demonstrate pressure gauge, Load cell, Bourdon tube, Capacitive transducers.		5 Nos.
82	Flow Transducers panel board to demonstrate Flow nozzle, Vane Anemometer, Rota meter.		5 Nos.
83	Temperature Transducers panel board to demonstrate Bimetallic strip, RTD, Thermocouple, Thermistor.		5 Nos.
84	Level Transducers panel board to demonstrate capacitive and float switch.		5 Nos.
85	Insulated Screw Diver	200 mm	5Nos.
86	Insulated combination cutting plier	200 mm	5Nos.
87	Small Screw Driver		5Nos.
C. TOOLS & EQUIPMENT OF ELECTRICAL & SENSORS			
i) Electrical			
88	Digital Multimeter	0 – 400 Volt	2 nos.
89	Variable Resistance Box, Resistors	With 220Ω, 150Ω, 1kΩ, 33Ω, 100Ω, 1.2Ω	1 each
90	9V DC Battery With Cap		1 no.
91	Dual Power Supply	(230V, 50Hz, Fuse-800mA)	1 no.
92	Solder Iron, Solder Lead, PCB Board (Groove Board), Solder Wick		1 set
93	Inductor	(400 Turns, 200 Turns, 600 Turns, 1200 Turns) , I-Core , E-Core, U-Core, Laminated Core	1 each
94	Relay, LED	(5V)	1 no.
95	Function Generator	(230V, 50Hz, Watts-12VA, Fuse-150mA)	1 no.
96	Bread Board		1 no.

97	Synchronous Motor, Capacitor For Synchronous Motor	(240V, 60rpm), (0.8mf ± 5% 450 VAC)	2 nos.
98	Power Chord, Connecting Probes, Single Strand & Multi strand Wires		1 each
ii) Sensors			
99	Power Supply	(0-30V DC, 3A)	1 no.
100	**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)	
D. MECHATRONICS LAB OUTFIT			
1	Discrete component tester Trainer kit		2 nos.
2	Analog circuit trainer kit		3 nos.
3	Soldering and de soldering Station		5 nos.
2	Power Electronic Trainer	(with all components for performing control rectifiers, Converter, Inverter experiments)	2 nos.
3	AC Squirrel cage Induction Motor	DOL Starter and star –Delta starter assembly	1 no.
4	DC motor Trainer board.		1 no.
5	Auto transformer	0 – 300 v, 8 Amp	2 nos.
6	C.R.O , 50 M Hz		2 nos.
7	Digital and Analog IC Tester		1 each
8	Digital Tachometer		2 nos.
9	Signal Generator		2 nos.
10	DC Power supply unit	0 - 30 v , 2 Amps	4 nos.
11	Digital Earth Tester		1 No.
12	Firefighting equipment		As required
13	Linear IC Trainer Kit		1No.
14	AC / DC Motor speed control trainer kit		1No. each

15	Optical Transducer Trainer kit.		2 Nos.
16	Simple Servomotor trainer kit.		2 Nos.
17	Simple stepper motor trainer kit.		2 Nos.
18	Linear scale setup for positional accuracy check		1 No.
19	A/D and D/A Trainer kit		1No
20	UPS		As required
21	Stabilizer Trainer kit		1No
22	AC Drive		4 Nos.
23	DC Drive		1 No.
24	Digital circuits trainer Kit.		2 Nos.
25	8051 Microcontroller trainer board with LED, Switches, Buzzer, DC motor and Stepper motor interfacing circuits.		3 Nos.
26	PLC with IO simulation panel and programming software with PLC application module		1No
27	Ethernet to Profibus converter		2 Nos.
28	HMI		2 Nos.
29	Personal Computers	CPU: 32/64 Bit i3/i5/i7 or latest processor, Speed: 3 GHz or Higher. RAM:-4 GB DDR-III or Higher, Wi-Fi Enabled. Network Card: Integrated Gigabit Ethernet, with USB Mouse, USB Keyboard and Monitor (Min. 17 Inch.) Licensed Operating System and Antivirus compatible with trade related software.	12 Nos.
30	Operating system (Windows latest version)		12 Users
31	Portable Hard Disk.(1 TB)		1No
32	MS-Office		10 Users.
33	RJ45,BNC,D-Shell, Edge Connector Crimping Tool		2 Nos. each
34	Megger		2 Nos.
35	Encoder Trainer Kit		1 No.
36	Panel Wiring Work bench		3 Nos.
37	Protection Devices Trainer Board.		1 Nos.
38	Limit switch, Pressure switch, Micro switch, Float switch, Foot switch		2each
39 *	Application trainer kit of proximity sensor, float switch, and reed		1No

	switch.		
40	LVDT Trainer kit.		2 Nos.
41	Actuators Application Trainer(Servo, stepper motor, and Solenoid)		1 No
42	Simple Servomotor trainer kit.		1 No.
43	Simple stepper motor trainer kit.		1 No.
44	Piezoelectric transducer/actuator trainer kit.		1 No.
45 *	Pneumatic control trainer kit with required pneumatic components.		3 Nos.
46 *	Hydraulic control trainer kit with required hydraulic components.		1No
47 *	Electro-Pneumatic control trainer kit using PLC with required components.	Two of these kits should be fitted with PLCs with facility to isolate PLC as and when required to utilize the kit as Electro-Pneumatic Kit.	4 Nos.
48 *	Electro-Hydraulic control trainer kit using PLC with required components.	One of these kits should be fitted with PLCs with facility to isolate PLC as and when required to utilize the kit as Electro-Pneumatic Kit.	2 Nos.
49 *	Linear scale setup for positional accuracy check		2 Nos.
50 *	PLC Based Conveyor System with Pick and Place and Sorting of Objects (Pneumatic and Hydraulic))		2 Nos.
51 *	Cut section Models of Pneumatic and Hydraulic Motors ,Pumps		Each 1 no.
52 *	Electrical simulator software		12 users license
53 *	Electronic simulator software		12 users license
54 *	Hydraulics and Pneumatics simulator software		12 users license
Note: *The items marked (*) need to be procured considering optimal utilization of resources. The different components with each trainer kits which are common in all NEED NOT TO BE procured separately for each kit. The common components may be utilized while performing the practical in different trainer kit. However, minimum 03 sets of common items must be there for effective training. The PLC may be of popular make such as Allen Bradley SLC 500 and SIEMENS PLC, etc.*			
E. GENERAL SHOP OUTFIT			

57.	Sensitive drilling machine	Capacity 12 mm Motorized –with drill chuck and key with Standard and optional accessories.	1No.
58.	Pillar/column type Drilling machine	25 mm capacity-motorized with drill chuck and Key with Standard and optional accessories.	1No.
59.	Power hacksaw machine	21" or more length blade with Standard and optional accessories.	1 No.
60.	Double ended Pedestal Grinder	178 mm wheels(one fine and one rough wheel)	1 No.
61.	SS and SC centre lathe (all geared) with minimum specification as:	Centre height 150 mm and centre distance 1000 mm along with 3 and 4 jaw chucks, Auto feed system, safety guard, taper turning attachment, motorized coolant system, lighting arrangement with standard accessories and optional accessories with set of cutting tools	1 No.
62.	Shearing machine (lever type) hand operated complete	300 mm blade length.	1 No.
63.	Universal Milling Machine	Standard and optional accessories and set of cutters.	2Nos.
64.	Horizontal and Vertical milling machine	Standard and optional accessories and set of cutters each.	1 Set
65.	Hydraulic Surface Grinding Machine	standard and optional accessories and set of wheels	1 No.
66.	Universal cylindrical grinding machine	Standard and optional accessories and set of wheels.	1 No.
67.	CNC turn Centre	[specification as per Annex-A (I)]	1 No.
68.	CNC Vertical Machining Centre	[specification as per Annex-A (II)]	1 No.
69.	Drafting /AutoCAD software	Latest version	12 license
70.	Mechanical parametric Design /Creo (proE) software	The above three items can be shared if any of the other trade equipment list includes them and need not be procured separately subject to the condition to share amongst maximum of three trades and nine units.	12 license
71.	**Simulation software** 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		12 license (can be used by other trades)

	such as Fanuc, Siemens, etc. (Web-based or licensed based) With help of this software the trainees should be able to Write, Edit, Verify & Simulate		

NOTE: -

1. *No additional items are required to be provided to the batch working in the second and third shift except the items under trainee's toolkit.*
2. *Institute having centralized computer lab may use the existing infrastructure to impart simulation training & in that case not required to procure* ***item No. 29*** *under Mechatronics Lab Outfit.*
3. ***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 the entire above training infrastructure. 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*.
4. Internet facility is desired to be provided in the class room.

ANNEXURE-A (I)

Detailed specification for CNC Lathe			
1.	**MACHINE CAPACITY**	**Units**	**Size**
a	Max. load on Chuck	Kg	Maximum 40
b	Machine weight nett	kg	1500 or higher
2.	**SPINDLE**		
a	Maximum spindle speed	RPM	4000 or higher
b	Type of drive		AC servo spindle motor (digital)
c	Front Bearing Dia. (ID)	mm	60 or higher
3.	**AXES**		
a	X - axis Travel	mm	200 or higher
b	Z - axis Travel	mm	290 or higher
c	Rapid traverse - X	m/min	10/15 or higher
d	Minimum programmable command- X/ Z	mm	0.001
e	Programmable feed range - X, Z axes	mm/min	10 - 10000
f	Type of drive		AC servo motor
g	Motor Torque - X axes	Nm	3 or higher
h	Motor torque - Z axis	Nm	6 or higher with brake
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
6.	**CNC SYSTEM**		
a	Control System	FANUC/Siemens	
b	Machine control panel	Feed rate, spindle speed override knob	
c	MPG (Manual pulse generator)	On machine operator panel	
d	CNC Features	Tool Offsets MDI	
7.	**COOLANT/LUBRICATION**		
a	Coolant tank Capacity	Litres	100 or higher
b	Coolant pump motor	kW	0.25
c	Coolant pump output	lpm	20 or higher
8.	**POWER SOURCE**		
a	Mains supply (± 10 %)		415 V, 3 Ph., 50Hz
b	Total connected load requirement		Approx. 15 kVA
9.	**STANDARD EQUIPMENT**		
a	Voltage Stabilizer	15 kVA	
b	Backup CD for PLC Ladder Logic	1 no.	
c	Machine lightning	1 no.	
d	Levelling pads and jacking screws	4 nos.	

e	Operation manual	1 no.	
f	Maintenance manual	1 no.	
g	Installation kit	1 no.	
h	Maintenance tool kit	1 no.	
10.	**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	Stabilizer	NEEL/SE RVOMAX/CONSUL/FARMAX	
e	Lubrication	CENLUBE/DROPCO	
f	Coolant Pump	RAJAMANE/GRU NDFOS	

11.	**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.	OD turning tool	2	4	Suitable inserts	5 sets	15
b.	OD grooving tool	2	4	Suitable inserts	5 sets	15
c.	Thread cutting tool	2	4		20	60
d.	ID turning tool	2	4		20	60
e.	ID threading tool	2	4	Suitable inserts	10	30
f.	C spanner for tightening tools in holder	1	2			
g.	Magnetic dial stand	1	2			
h.	Mallet	2	4			
i.	Tap wrench	1	2			
j.	Hands tools set (spanners, Allen keys, etc.)	1 box				
k.	T Nuts, Strap clamps, Clamping Nuts and studs	1 set				
l.	Hands tools set (spanners, Allen keys, etc.,)	1 box				
m.	T Nuts, Strap clamps, Clamping Nuts and studs	1 set				

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	Levelling 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.	Hands tools set (spanners, Allen keys, etc.,)	1 box				
x.	T Nuts, Strap clamps, Clamping Nuts and studs	1 set				

ANNEXURE-II

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

List of Expert members contributed/ participated for finalizing the course curriculum of Technician Mechatronics trade held on 23.08.2017 at ITI-Aundh, Pune.			
S. No.	**Name & Designation Shri/Mr./Ms.**	**Organization**	**Remarks**
Industry Experts			
1.	Uday J. Apte, Dy. General Manager.-Trg.	TATA Motors, Ahmadabad	Chairman
2.	Nirmalya Nath Asst. Director of Trg.	CSTARI, Kolkata	Member cum Co-coordinator
3.	Ananda K. Jagdale, Manager-Training	Volkswagen India Pvt. Ltd, Chakan, Pune	Member
4.	Deepak M. Patil, Dy. General Manager- Product Development	Nichrome India Ltd.	Member
5.	Amol M. Jangam, Senior Production Engineer	Anshuman Tech. Pvt. Ltd.	Member
6.	Javed F. Attar, Craft Instructor Mechanic Mechatronics	Govt. Industrial Training Institute, Duelor 28	Member
7.	N.G. Joshi, AGM- MKTG/DIDACTIC	Janatics (India) Pvt. Ltd., Pune	Member
8.	KunalSahare, Asst. Mgr./ Trg. & Dev.	Janatics (India) Pvt. Ltd., Pune	Member
9.	Kulkarni D.V., Training Officer (Sr.)	Industrial Automation Govt. ITI, Aundh, Pune	Member
10.	Pawade S.B, Training Officer	AMTM Electrical (AVTS), Govt. ITI-Aundh, Pune	Member
11.	Yogesh M. Torpe, Training Officer- Hydraulic	AVTS c/o ITI- Aundh, Pune-67	Member
12.	Tikone A.R., Welder Instructor	ITI- Aundh, Pune	Member
13.	Sachin M. Lamse, Craft Instructor- Turner	ITI Aundh, Pune	Member
14.	Ashish Kulkarni,	FESTO India	Member

	Sr. Sales Engg./ Didactic		
15.	Shashwat R. Bhure, Sr. Sales Engg./ Didactic	FESTO India	Member
16.	K. Srinivasan, Sales Manager, Educational Institutions	DMG Mori India	Member
17.	AmilBhingurde, COO- Robotics	TAL Manufacturing Solutions Ltd. , Pune	Expert
18.	Santosh Thorat, Sales Manager- ROBOTICS	TAL Manufacturing Solutions Ltd. , Pune	Expert
19.	Rohan Kadlay	Siemens India Ltd., Pune	Expert
20.	Lakshmanan R.	Bosch India Ltd., Bangalore	Expert
21.	Chandrashekhar V. Varekar	Ex- ChristianiSharpline India Ltd.,	Expert
DGT & Training Institute			
22.	Ujjwal Biswas, Deputy Director	ATI, Mumbai, M/o Skill Development	Member
23.	L.K. Mukherjee, Deputy Director	CSTARI, Kolkata	Member
24.	P.L. Sayagaonkar, Principal	ITI Aundh, Pune	Member
25.	N.M. Kajale, Sr. Training Officer	Hi-Tech Training Scheme, Aundh Pune	Member
26.	C. Ravi, Deputy Director	ATI, Mumbai, M/o Skill Development	Expert

ABBREVIATIONS

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


कौशलं बलम्