



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- 5



SECTOR – PRODUCTION & MANUFACTURING

TECHNICIAN MECHATRONICS

(Engineering Trade)

(Designed in 2018)

Version: 1.0

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL - 5

Developed By

Ministry of Skill Development and Entrepreneurship
Directorate General of Training
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1. COURSE INFORMATION

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

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

1st Semester – In this semester, 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 semester. The safety aspects covers components like OSH&E, PPE, Fire extinguisher, First Aid and in addition 5S of Kaizen is being taught.

2nd Semester – In this semester, 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 on basic programming of Microcontroller and its Interfacing techniques, troubleshooting of electrical & electronics system are also covered.

3rd Semester – 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 Understand the principles of hydraulics, the basic functions of hydraulic systems, the 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.

4th Semester – 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, assemble 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

Directorate General of Training (DGT) under Ministry of Skill Development & Entrepreneurship offers range of vocational training courses catering to the need of different sectors of economy/ Labour market. The vocational training programmes are delivered under aegis of National Council of Vocational Training (NCVT). Craftsman Training Scheme (CTS) and Apprenticeship Training Scheme (ATS) are two pioneer programmes of NCVT for propagating vocational training.

CTS courses are delivered nationwide through network of ITIs. The course ‘Technician Mechatronics’ is of two-years (04 semester) duration. It mainly consists of trade (skills and knowledge) and Core area (Workshop Calculation & Science, Engineering Drawing and Employability Skills). After passing out of the training program, the trainee is awarded National Trade Certificate (NTC) by NCVT which is recognized worldwide.

Trainee broadly needs to demonstrate that they are able to:

- Read & 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 CAREER PROGRESSION PATHWAYS:

- 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.

2.3 COURSE STRUCTURE:

Table below depicts the distribution of training hours across various course elements during a period of two-year (04 semesters) is as follows:

S No.	Course Element	Notional Training Hours
1	Professional Skill (Trade Practical)	2213
2	Professional Knowledge (Trade Theory)	510
3	Workshop Calculation & Science	170
4	Engineering Drawing	255
5	Employability Skills	110
6	Library & Extracurricular activities	142
7	Project work	200
8	Revision & Examination	560
	Total	4160

2.4 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude during the period of the course and at the end of the training program as notified by the Government of India (GoI) from time to time. The employability skills will be tested in the first two semesters itself.

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

b) The final assessment will be in the form of summative assessment method. The All India Trade Test for awarding NTC will be conducted by NCVT at the end of each semester as per the guideline of Government of India. The pattern and marking structure is being notified by Govt. of India from time to time. **The learning outcome and assessment criteria will be the basis for setting question papers for final assessment. The examiner during final examination will also check** the individual trainee's profile as detailed in assessment guideline before giving marks for practical examination.

2.4.1 PASS REGULATION

The minimum pass percentage for practical is 60% & minimum pass percentage of theory subjects is 40%. For the purposes of determining the overall result, 25% weightage is applied to the result of each semester examination.

2.4.2 ASSESSMENT GUIDELINE

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

Assessment will be evidence based comprising the following:

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

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

Performance Level	Evidence
(a) Weightage in the range of 60%-75% to be allotted during assessment	
For performance in this grade, the candidate should produce work which demonstrates attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and practices	<ul style="list-style-type: none"> • Demonstration of good skill in the use of hand tools, machine tools and workshop equipment. • Below 70% tolerance dimension achieved while undertaking different work with those demanded by the component/job. • A fairly good level of neatness and consistency in the finish. • Occasional support in completing the project/job.
(b) Weightage in the range of 75%-90% to be allotted during assessment	
For this grade, a candidate should produce work which demonstrates attainment of a reasonable standard of craftsmanship, with little guidance, and regard for safety procedures and practices	<ul style="list-style-type: none"> • Good skill levels in the use of hand tools, machine tools and workshop equipment. • 70-80% tolerance dimension achieved while undertaking different work with those demanded by the component/job. • A good level of neatness and consistency in the finish.

	<ul style="list-style-type: none"> • Little support in completing the project/job.
(c) Weightage in the range of more than 90% to be allotted during assessment	
<p>For performance in this grade, the candidate, with minimal or no support in organization and execution and with due regard for safety procedures and practices, has produced work which demonstrates attainment of a high standard of craftsmanship.</p>	<ul style="list-style-type: none"> • High skill levels in the use of hand tools, machine tools and workshop equipment. • Above 80% tolerance dimension achieved while undertaking different work with those demanded by the component/job. • A high level of neatness and consistency in the finish. • Minimal or no support in completing the project.

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.

May be designated as “Technician Mechatronics” according to nature of work done.

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

4. GENERAL INFORMATION

Name of the Trade	Technician Mechatronics
NCO - 2015	7233.0100, 7233.0101, 7412.0101, 7412.0201, 7411.0100, 7421.0300
NSQF Level	Level – 5
Duration of Craftsmen Training	Two years (Four semesters each of six months duration).
Entry Qualification	Passed 10 th Class with Science and Mathematics under 10+2 system of Education or its equivalent
Unit Strength (No. Of Student)	20 (Max. supernumeraries seats: 6)
Space Norms	192 Sq. m
Power Norms	8 KW
Instructors Qualification for	
1. Technician Mechatronics Trade	<p>Degree in Mechatronics / Mechanical/ Instrumentation / Electrical Engineering from recognized Engineering College /university with one year experience in the relevant field.</p> <p style="text-align: center;">OR</p> <p>Diploma in Mechanical/Electrical/Instrumentation/ Mechatronics Engineering from recognized board of technical education with two years experience in the relevant field.</p> <p style="text-align: center;">OR</p> <p>NTC/NAC in the Trade of “Mechatronics” With 3 years’ post qualification experience in the relevant field.</p> <p><i>Out of two Instructors required for the unit of 2(1+1), one must have Degree/Diploma and other must have NTC/NAC qualifications.</i></p>
2. Workshop Calculation & Science	<p>Degree in Mechanical Engineering with two year practical experience in a tool room.</p> <p style="text-align: center;">OR</p> <p>Diploma in Technician Mechatronics Making with three years practical experience. in a tool room</p> <p>Desirable: Craft Instructor Certificate in RoD& A course under NCVT.</p>
3. Engineering Drawing	<p>Degree in Mechanical Engineering with one year experience.</p> <p style="text-align: center;">OR</p> <p>Diploma in Mechanical Engineering with two years experience.</p> <p style="text-align: center;">OR</p> <p>NTC / NAC in the Draughtsman (Mechanical) with three years experience.</p>

	Desirable: Craft Instructor Certificate in RoD & A course under NCVT.					
4. Employability Skill	<p>MBA OR BBA with two years experience OR Graduate in Sociology/ Social Welfare/ Economics with Two years experience OR Graduate/ Diploma with Two years experience and trained in Employability Skills from DGET institutes.</p> <p style="text-align: center;">AND</p> <p>Must have studied English/ Communication Skills and Basic Computer at 12th / Diploma level and above.</p> <p style="text-align: center;">OR</p> <p>Existing Social Studies Instructors duly trained in Employability Skills from DGT institutes.</p>					
List of Tools and Equipment	As per Annexure – I					
Distribution of training on Hourly basis: (Indicative only)						
Total hours /week	Trade practical	Trade theory	Work shop Cal. &Sc.	Engg. Drawing / Mould design Drawing	Employability skills	Extra-curricular activity
40 Hours	25 Hours	6 Hours	2 Hours	3 Hours	2 Hours	2 Hours

5. NSQF LEVEL COMPLIANCE

NSQF level for Technician Mechatronics trade under CTS: **Level 5.**

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

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

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

- a. Process
- b. professional knowledge
- c. professional skill
- d. core skill
- e. Responsibility

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

The NSQF Level – 5 descriptor is given below:

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

6. LEARNING/ ASSESSABLE OUTCOME

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

6.1 GENERIC LEARNING OUTCOME

1. Recognize & comply safe working practices, environment regulation and housekeeping.
2. Understand and explain different mathematical calculation & science in the field of study including basic electrical. [*Different mathematical calculation & science -Work, Power & Energy, Algebra, Geometry & Mensuration, Trigonometry, Heat & Temperature, Levers & Simple machine, graph, Statistics, Centre of gravity, Power transmission, Pressure*]
3. Interpret specifications, different engineering drawing and apply for different application in the field of work. [*Different engineering drawing-Geometrical construction, Dimensioning, Layout, Method of representation, Symbol, scales, Different Projections, Machined components & different thread forms, Assembly drawing, Sectional views, Estimation of material, Electrical & electronic symbol*]
4. Select and ascertain measuring instrument and measure dimension of components and record data.
5. Explain the concept in productivity, quality tools, and labour welfare legislation and apply such in day to day work to improve productivity & quality.
6. Explain energy conservation, global warming and pollution and contribute in day to day work by optimally using available resources.
7. Explain personnel finance, entrepreneurship and manage/organize related task in day to day work for personal & societal growth.
8. Plan and organize the work related to the occupation.

6.2 SPECIFIC LEARNING OUTCOME

Semester – I

9. Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check for dimensional accuracy. [Basic fitting operation – Filing, Marking, Hack sawing, Drilling, Taping, chipping and Grinding etc. Accuracy: $\pm 0.1\text{mm}$]
10. Make 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: $\pm 0.05\text{ mm}$]

11. 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)*)
12. Carryout different computer operation and trouble shoot. [Different computer operations: setting of computer & MS Office operation]
13. Perform joining of metals by welding and brazing observing standard procedure.

Semester – II

14. 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.*]
15. 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.*]
16. Estimate and perform panel wiring using cables, connectors, Protective devices and test functionality.
17. Construct and verify different Digital Logic Circuits.
18. Install different software in computer system and test. [*Different software: Office, Multimedia, Fluidsim, PLC, etc.*]
19. Write an assembly level programme and interface peripherals to 8051 Microcontroller to check functioning.
20. Trouble shoot and repair different Electrical, Electronic systems/ devices. [*Different Electrical, Electronic systems/ devices:- Fuse, MCB, Power circuit, Control panel, Circuit Breaker, Stabilizer, AC/DC drives.*]
21. Demonstrate function of different sensors. [*Different sensors: Proximity Sensors, inductive sensor, capacitive sensor, magnetic sensor, Reflex Photoelectric Sensors, Temperature Sensors, etc.*]

Semester – III

22. Set (both job and tool) CNC turn centre and milling machine to produce simple components as per drawing.
23. Construct simple pneumatic control system to measure various parameters using transducer, sensor and switches. [Various parameter: pressure, flow, level of oil, load displacement]

24. Check various components of pneumatics system and construct pneumatic circuit to check functionality.
25. Construct an electro-pneumatic circuit and check functionality of a process. [E.g.- process: Automatic braking system.]
26. Install an electro-pneumatic system and trouble shoot faults.
27. Construct simple hydraulic circuit and check functionality.
28. Demonstrate installation of accessories in hydraulic system and trouble shoot defects.
29. Construct hydraulic circuit; verify various processes to assess functioning of valves and auxiliaries. [Various processes: - speed control, lub system, press control etc.]
30. Install hydraulic pump, motors and carryout maintenance of these components.
31. 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.]
32. Programme PLC and interface with other devices to check its Applications.

Semester – IV

33. Explain robot anatomy and perform programming robot using teach box, software.
34. Simulate the electrical circuits on simulation software and detect fault as per diagnostic procedure for Electrical system design.
35. Simulate the electronic circuits on simulation software and detect fault as per diagnostic procedure for Electronics system design.
36. Simulate the Hydraulic and Pneumatic circuit on simulation software and detect fault as per diagnostic procedure for Hydraulics and Pneumatics system design.
37. 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*).

7. LEARNING OUTCOME WITH ASSESSMENT CRITERIA

GENERIC LEARNING/ ASSESSABLE OUTCOME	
LEARNING/ ASSESSABLE OUTCOME	ASSESSMENT CRITERIA
1. Recognize and comply safe working practices, environment regulation and housekeeping.	1.1 Follow and maintain procedures to achieve a safe working environment in line with occupational health and safety regulations and requirements.
	1.2 Recognize and report all unsafe situations according to site policy.
	1.3 Identify and take necessary precautions on fire and safety hazards and report according to site policy and procedures.
	1.4 Identify, handle and store / dispose off dangerous/unsalvageable goods and substances according to site policy and procedures following safety regulations and requirements.
	1.5 Identify and observe site policies and procedures in regard to illness or accident.
	1.6 Identify safety alarms accurately.
	1.7 Report supervisor/ Competent authority in the event of accident or sickness of any staff and record accident details correctly according to site accident/injury procedures.
	1.8 Identify and observe site evacuation procedures according to site policy.
	1.9 Identify Personal Protective Equipment (PPE) and use the same as per related working environment.
	1.10 Identify basic first aid and use them under different circumstances.
	1.11 Identify different fire extinguisher and use the same as per requirement.
	1.12 Identify environmental pollution and contribute to avoidance of same.
	1.13 Take opportunities to use energy and materials in an environmentally friendly manner
	1.14 Avoid waste and dispose waste as per procedure
	1.15 Recognize different components of 5S and apply the same in the working environment.
2. Understand, explain different mathematical calculation and science in the field of study including basic electrical and apply	2.1 Explain concept of basic science related to the field such as Material science, Mass, weight, density, speed, velocity, heat and temperature, force, motion, pressure, heat treatment, centre of gravity, friction.
	2.2 Measure dimensions as per drawing

<p>in day to day work. [Different mathematical calculation and science -Work, Power and Energy, Algebra, Geometry and Mensuration, Trigonometry, Heat and Temperature, Levers and Simple machine, graph, Statistics, Centre of gravity, Power transmission, Pressure]</p>	2.3 Use scale/ tapes to measure for fitting to specification.
	2.4 Comply given tolerance.
	2.5 Prepare list of appropriate materials by interpreting detail drawings and determine quantities of such materials.
	2.6 Ensure dimensional accuracy of assembly by using different instruments/gauges.
	2.7 Explain basic electricity, insulation and earthing.
<p>3. Interpret specifications, different engineering drawing and apply for different application in the field of work. [Different engineering drawing- Geometrical construction, Dimensioning, Layout, Method of representation, Symbol, scales, Different Projections, Machined components and different thread forms, Assembly drawing, Sectional views, Estimation of material, Electrical and electronic symbol]</p>	3.1 Read and interpret the information on drawings and apply in executing practical work.
	3.2 Read and analyse the specification to ascertain the material requirement, tools, and machining /assembly /maintenance parameters.
	3.3 Encounter drawings with missing/unspecified key information and make own calculations to fill in missing dimension/parameters to carry out the work.
<p>4. Select and ascertain measuring instrument and measure dimension of components and record data.</p>	4.1 Select appropriate measuring instruments such as micrometres, vernier callipers, dial gauge, bevel protector and height gauge (as per tool list).
	4.2 Ascertain the functionality and correctness of the instrument.
	4.3 Measure dimension of the components and record data to analyse the with given drawing/measurement.
<p>5. Explain the concept in productivity, quality tools, and labour welfare legislation and apply such in day to day work to improve productivity and quality.</p>	5.1 Explain the concept of productivity and quality tools and apply during execution of job.
	5.2 Understand the basic concept of labour welfare legislation and adhere to responsibilities and remain sensitive towards such laws.
	5.3 Knows benefits guaranteed under various acts

6. Explain energy conservation, global warming and pollution and contribute in day to day work by optimally using available resources.	<p>6.1 Explain the concept of energy conservation, global warming, pollution and utilize the available recourses optimally and remain sensitive to avoid environment pollution.</p> <p>6.2 Dispose waste following standard procedure.</p>
7. Explain personnel finance, entrepreneurship and manage/organize related task in day to day work for personal and societal growth.	<p>7.1 Explain personnel finance and entrepreneurship.</p> <p>7.2 Explain role of Various Schemes and Institutes for self-employment i.e. DIC, SIDA, SISI, NSIC, SIDO, Idea for financing/ non financing support agencies to familiarizes with the Policies /Programmes and procedure and the available scheme.</p> <p>7.3 Prepare Project report to become an entrepreneur for submission to financial institutions.</p>
8. Plan and organize the work related to the occupation.	<p>8.1 Use documents, drawings and recognize hazards in the work site.</p> <p>8.2 Plan workplace/ assembly location with due consideration to operational stipulation</p> <p>8.3 Communicate effectively with others and plan project tasks</p> <p>8.4 Assign roles and responsibilities of the co-trainees for execution of the task effectively and monitor the same.</p>

SPECIFIC LEARNING/ ASSESSABLE OUTCOME	
Semester-I	
LEARNING/ ASSESSABLE OUTCOME	ASSESSMENT CRITERIA
9. Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check for dimensional accuracy. [Basic fitting operation – Filing, Marking, Hack sawing, Drilling, Taping, chipping and Grinding etc. Accuracy: $\pm 0.1\text{mm}$]	9.1 Plan and Identify tools, instruments and equipment for marking and make this available timely.
	9.2 Select raw material and visual inspection for defects.
	9.3 Mark as per specification applying desired mathematical calculation and observing standard procedure.
	9.4 Identify Hand Tools for different fitting operations and make these available timely.
	9.5 Prepare the job for Hacksawing, chiselling, filing.
	9.6 Perform basic fitting operations viz., Hacksawing, filing and Chipping of close tolerance as per specification to make the job.
	9.7 Observe safety procedure during above operations as per standard norms and guidelines.
	9.8 Measure and Check all dimensions of the work pieces as per standard procedure in accordance with specifications and tolerances.
	9.9 Identify unused materials and components for storing in an appropriate environment and prepare for disposal.
10. Make 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: $\pm 0.05\text{ mm}$]	10.1 Recognize general concept of Limits, Fits and tolerances necessary for fitting applications and functional application of these parameters.
	10.2 Plan and Identify tools, instruments and equipment for workpiece and make this available timely.
	10.3 Set up workplace/ assembly location with due consideration to operational stipulation.
	10.4 Plan work in compliance with standard safety norms and collecting desired information.
	10.5 Demonstrate possible solutions and agree tasks within the team.
	10.6 Make components according to the specification for different fits using a range of practical skills including scraping and ensuring interchangeability of

	different parts.
	10.7 Measure the components using Vernier, Micrometer, Height gauge.
	10.8 Assemble components applying a range of skills to ensure proper fit.
	10.9 Check functionality of components.
11. Produce components involving different operations on Lathe, Milling and Grinding machines observing standard procedure and check for accuracy. (<i>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)</i>)	11.1 Ascertain basic working principles and safety aspects of machines.
	11.2 Understand functional application of different levers, stoppers, adjustment etc.
	11.3 Identify different lubrication points and lubricants, their usage for application in machines as per machine manual.
	11.4 Identify different work and tool holding devices and collect information for functional application of each device.
	11.5 Mount the work and tool holding devices with required alignment and check for its functional usage to perform machining operations.
	11.6 Solve problem by applying basic methods, tools, materials and information during setting.
	11.7 Observe safety procedure during mounting as per standard norms.
	11.8 Produce components observing standard procedure.
	11.9 Check accuracy/ correctness of job using appropriate equipment/gauge.
	11.10 Identify unused materials and components for storing in an appropriate environment and prepare for disposal.
12. Carryout different computer operation and trouble shoot. [Different computer operations: setting of computer & MS Office operation]	12.1 Collect relevant information to operate and trouble shoot computer
	12.2 Set the computer and carryout basic computer related operation using MS Office
	12.3 Conduct basic trouble shooting of PC.
13. Perform joining of metals by welding	13.1 Plan and select the type & size of electrode, welding

and brazing observing standard procedure.	current, nozzle size, working pressure type of flame, filler rod and flux as per requirement as per process requirement.
	13.2 Prepare edge as per requirement
	13.3 Prepare, set SMAW machine/Gas welding plant and tack the pieces as per drawing.
	13.4 Set up the tacked pieces in specific position.
	13.5 Deposit the weld maintaining appropriate arc length, electrode angle, welding speed, weaving technique / Braze the joint adapting proper brazing technique and safety aspects.
	13.6 Clean the welded joint thoroughly.
	13.7 Carry out visual inspection for appropriate weld joint & check by gauges.
Semester-II	
14. Construct different electrical sub-systems and measure parameters. <i>[Different electrical sub-systems: - AC/DC Motors, DC machine, DC motors, DC motor starter, Universal motor, Induction motor, AC drive, Servo drive, transformer.]</i>	4.1 Plan and identify tools, instruments and equipment for the work and make it available timely.
	4.2 Set up workplace/ assembly location with due consideration to operational stipulation.
	4.3 Plan work in compliance with standard safety norms and collecting desired information.
	4.4 Demonstrate possible solutions and agree tasks within the team.
	4.5 Trouble shoot & test different electrical sub system.
15. Construct different electronics sub system and test electronic devices and sub system. <i>[Different sub system: - Diodes, rectifier circuit, voltage regulator, transistor power electronic devices, op-amp circuit, LED circuit, SCR etc.]</i>	15.1 Plan and identify tools, instruments and equipment for the work and make it available timely.
	15.2 Set up workplace/ assembly location with due consideration to operational stipulation.
	15.3 Plan work in compliance with standard safety norms and collecting desired information.
	15.4 Demonstrate possible solutions and agree tasks within the team.
	15.5 Construct different electronics subsystem test electronics devices and subsystems.
16. Estimate and perform panel wiring using cables, connectors, Protective devices and test functionality.	16.1 Plan and estimate material requirement for panel wiring.
	16.2 Identify tools equipment for the work and make it available timely.

	16.3 Set up workplace/ assembly location with due consideration to operational stipulation.
	16.4 Plan work in compliance with standard safety norms and collecting desired information.
	16.5 Perform panel wirings.
17. Construct and verify different Digital Logic Circuits. [Different DLC:- Logic Gates, half & full adder, binary & outer, P/ down counter.]	17.1 Plan and identify tools, instruments and equipment for the work and make it available timely.
	17.2 Construct and verify digital logic circuits.
18. Install different software in computer system and test. [Different software: Office, Multimedia, Fluidsim, PLC, etc.]	18.1 Identify different components/ parts of PC.
	18.2 Collect relevant information for installing software.
	18.3 Check operation of computers.
	18.4 Install software in the computer and check its functioning.
19. Write an assembly level programme and interface peripherals to 8051 Microcontroller to check functioning.	19.1 Write Basic Assembly language Programming.
	19.2 Interface peripherals to 8051 Microcontroller.
	19.3 Check the functioning as per programme.
20. Trouble shoots and repairs different Electrical, Electronic systems/ devices. [Different Electrical, Electronic systems/ devices:- Fuse, MCB, Power circuit, Control panel, Circuit Breaker, Stabilizer, AC/DC drives.]	20.1 Plan and identify tools, instruments and equipment for the work and make it available timely.
	20.2 Plan work in compliance with standard safety norms and collecting desired information.
	20.3 Demonstrate possible solutions and agree tasks within the team.
	20.4 Trouble shoot and repair electrical & electronics system/ devices observing safety procedure.
	20.5 Check the functionality of the system.
21. Demonstrate function of different sensors. [Different sensors: Proximity Sensors, inductive sensor, capacitive sensor, magnetic sensor, Reflex Photoelectric Sensors, Temperature Sensors, etc.]	21.1 Demonstrate the Behaviour of Proximity Sensors and ultra sonic sensors and logic operation of sensors.
	21.2 Limits and level control using sensors.
	21.3 Interfacing of sensors with electrical actuators.
Semester-III	

22. Set (both job and tool) CNC turn centre and milling machine to produce simple components as per drawing	22.1 Operation of CNC machine in different Modes [JOG, MPG, MDI, EDIT, AUTO].
	22.2 Operation of CNC machine using G codes and M codes, Measure offset –Work and Tool Offset for Turning and Milling
	22.3 Tool Path simulation for Turning and Milling.
	22.4 Working on tool handling and work handling:- Methods of mounting Tool and work –use of cutting tool as per material and tool cutter compensation.
	22.5 Program Preparation and Practice on Plain, step and taper turning, Face Milling and Step Milling.
	22.6 Check for dimensional accuracy of job using appropriate gauges and measuring instruments.
23. Construct simple pneumatic control system to measure various parameters using transducer, sensor and switches. [Various parameter: pressure, flow, level of oil, load displacement]	23.1 Plan and identify tools, instruments and equipment for the work and make it available timely.
	23.2 Set up workplace/ assembly location with due consideration to operational stipulation.
	23.3 Plan work in compliance with standard safety norms and collecting desired information.
	23.4 Construct pneumatic control system as per design/ application requirement.
	23.5 Measure various parameters as per the set up.
	23.6 Record data as per standard format/ designed chart.
24. Check various components of pneumatics system and construct pneumatic circuit to check functionality.	24.1 Identify various components of pneumatic system and check their functionality.
	24.2 Plan and identify tools, instruments and equipment for the work and make it available timely.
	24.3 Set up workplace/ assembly location with due consideration to operational stipulation.
	24.4 Plan work in compliance with standard safety norms and collecting desired information.
	24.5 Construct pneumatic circuits and check their functionality.
25. Construct an electro-pneumatic circuit and check functionality of a process. [E.g.-process: Automatic	25.1 Plan and identify tools, instruments and equipment for the work and make it available timely.
	25.2 Set up workplace/ assembly location with due

braking system.]	consideration to operational stipulation.
	25.3 Plan work in compliance with standard safety norms and collecting desired information.
	25.4 Construct electro-pneumatic circuit as per design/ application requirement.
	25.5 Check the functioning of processes as per desired requirement.
26. Install an electro-pneumatic system and trouble shoot faults.	26.1 Plan and identify tools, instruments and equipment for the work and make it available timely.
	26.2 Set up workplace/ assembly location with due consideration to operational stipulation.
	26.3 Plan work in compliance with standard safety norms and collecting desired information.
	26.4 Construct and Install electro-pneumatic system as per design/ application requirement.
	26.5 Check the functioning of system as per desired requirement.
	26.6 Trouble shoot the faults during functioning.
27. Construct simple hydraulic circuit and check functionality.	27.1 Plan and identify tools, instruments and equipment for the work and make it available timely.
	27.2 Set up workplace/ assembly location with due consideration to operational stipulation.
	27.3 Plan work in compliance with standard safety norms and collecting desired information.
	27.4 Construct simple hydraulic circuit as per design/ application requirement.
	27.5 Check the functionality of the circuit.
28. Demonstrate installation of accessories in hydraulic system and trouble shoot defects.	28.1 Plan and identify tools, instruments and equipment for the work and make it available timely.
	28.2 Set up workplace/ assembly location with due consideration to operational stipulation.
	28.3 Plan work in compliance with standard safety norms and collecting desired information.
	28.4 Demonstrate the possible solution and agree tasks within the team.
	28.5 Install accessories in hydraulic system as per design/

	application requirement.
	28.6 Check the functioning of system as per desired requirement.
	28.7 Trouble shoot the faults during functioning.
29. Construct hydraulic circuits verify various processes to assess functioning of valves and auxiliaries. [Various processes:- speed control, flow control, lub system, press control etc.]	29.1 Plan and identify tools, instruments and equipment for the work and make it available timely.
	29.2 Set up workplace/ assembly location with due consideration to operational stipulation.
	29.3 Plan work in compliance with standard safety norms and collecting desired information.
	29.4 Construct hydraulic circuit as per design/ application requirement.
	29.5 Verify processes to ascertain functioning of valves and auxiliaries.
30. Install hydraulic pump, motors and carryout maintenance of these components.	30. 1 Plan and identify tools, instruments and equipment for the work and make it available timely.
	30. 2 Set up workplace/ assembly location with due consideration to operational stipulation.
	30. 3 Plan work in compliance with standard safety norms and collecting desired information.
	30. 4 Install hydraulic pump & motors as per design/ application requirement.
	30. 5 Check the functioning of system as per desired requirement.
	30. 6 Carryout maintenance of these components during non-functioning.
31. 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.]	31. 1 Plan and identify tools, instruments and equipment for the work and make it available timely.
	31. 2 Set up workplace/ assembly location with due consideration to operational stipulation.
	31. 3 Plan work in compliance with standard safety norms and collecting desired information.
	31. 4 Demonstrate the possible solution and agree tasks within the team.
	31. 5 Construct hydraulic system as per design/ application requirement.

	31. 6 Operate to verify functioning of hydraulic system.
32. Programme PLC and interface with other devices to check its Applications.	32. 1 Programme a PLC as per application requirement. 32. 2 Interface PLC with other devices observing standard procedure and safety. 32. 3 Check the functionality of device as per programme.
Semester – IV	
33. Explain robot anatomy and perform programming robot using teach box, software.	33. 1 Explain anatomy of robot 33. 2 Collect relevant information to programme robot via teach box, software. 33. 3 Programme robot via teach box, software 33. 4 Test functionality.
34. Simulate the electrical circuits on simulation software and detect fault as per diagnostic procedure for Electrical system design.	34.1 Develop electrical circuit as per desired application 34.2 Assemble and test Electrical Circuit on simulation software 34.3 Detect fault observing diagnostic procedure and rectify using simulation software 34.4 Rectify by resetting errors using simulation software
35. Simulate the electronic circuits on simulation software and detect fault as per diagnostic procedure for Electronics system design.	35. 1 Develop electronic circuit as per desired application 35. 2 Assemble and test Electronic Circuit on simulation software 35. 3 Detect fault observing diagnostic procedure and rectify using simulation software 35. 4 Rectify by resetting errors using simulation software
36. Simulate the Hydraulic and Pneumatic circuit on simulation software and detect fault as per diagnostic procedure for Hydraulics and Pneumatics system design.	36. 1 Develop Hydraulic and Pneumatic circuit as per desired application 36. 2 Assemble and test Hydraulic and Pneumatic circuit on simulation software 36. 3 Detect fault observing diagnostic procedure and rectify using simulation software 36. 4 Rectify by resetting errors using simulation software
37. Perform project work on	37. 1 Manufacture and assemble Mechanical sub system

<p><i>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)</i></p>	37. 2 Prepare Pneumatic circuit and interface
	37. 3 Prepare Electrical/Electronic circuit and interface
	37. 4 Develop and download PLC program
	37. 5 Integrate, Test and Repair for functionality

SYLLABUS FOR TECHNICIAN MECHATRONICS TRADE

First Semester - Six Month

Week No.	Ref. Learning Outcome	Professional Skills (Trade Practical) With Indicative Hrs	Professional Knowledge (Trade Theory)
1 - 2	Recognize & comply safe working practices, environment regulation and housekeeping.	<ol style="list-style-type: none"> 1. Introduction of trade skill and work application. (02 hrs) 2. Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). (05 hrs) 3. First Aid Method and basic training. (02 hrs) 4. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. (02 hrs) 5. Hazard identification and avoidance. (02 hrs) 6. Identification of safety signs for Danger, Warning, caution & personal safety message. (01 hr) 7. Preventive measures for electrical accidents & steps to be taken in such accidents. (02 hrs) 8. Use of Fire extinguishers. (07 hrs) 9. Practice and understand precautions to be followed while working in fitting jobs. (02 hrs) 10. Importance of trade training, List of tools & Machinery used in the trade. (01 hr) 11. Safe use of tools and equipments used in the trade. (01 hr) 12. Practice memory training and games. (15 hrs) 13. Workshop on Motivation. (by experts). (05 hrs) 14. 5S training. (03 hrs) 	<p>All necessary guidance to be provided to the new comers to become familiar with the working of Industrial Training Institute system including stores procedures.</p> <p>Safe working practices</p> <p>Soft Skills, its importance and Job area after completion of training.</p> <p>Importance of safety and general precautions observed in the industry/shop floor.</p> <p>Introduction of First aid. Operation of electrical mains and electrical safety.</p> <p>Introduction of PPEs.</p> <p>Response to emergencies e.g.; power failure, fire, and system failure.</p> <p>Importance of housekeeping & good shop floor practices.</p> <p>Introduction to 5S concept & its application.</p> <p>Occupational Safety & Health: Health, Safety and Environment guidelines, legislations & regulations as applicable.</p>
3	Plan and organize the work to make	<ol style="list-style-type: none"> 15. Identification of tools & equipments as per desired 	Bench work – Metal working hand tools and devices –Work bench – vices

	job as per specification applying different types of basic fitting operation and Check for dimensional accuracy. [Basic fitting operation – Filing, Marking, Hack sawing, Drilling, Taping, chipping and Grinding etc. Accuracy: $\pm 0.1\text{mm}$]	<p>specifications for filing and marking, visual inspection of raw material for rusting, scaling, corrosion etc. (03 hrs)</p> <p>16. Familiarization of bench vice. (01 hr)</p> <p>17. Filing- File top of the “U” channel, check and measure with steel rule. (10 hrs)</p> <p>18. Mark with scribe and steel rule (01 hr)</p> <p>19. Familiarization of Vernier Height Gauge. (08 hrs)</p> <p>20. Measuring practice with steel rule, Vernier Height Gauge. (02 hrs)</p>	<p>– files – hacksaw – hammer – chisels – spanners – screw drivers – scrapers.</p> <p>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.</p>
4 - 5	-do-	<p>21. File, mark straight and parallel lines with scribe and steel rule/Vernier Height Gauge as per drawing. (05 hrs)</p> <p>22. Dot punching and letter and number punching. (05 hrs)</p> <p>23. File “U” channel to size and by using straight edge, try-square and vernier calliper measure and check- Accuracy $\pm 0.1\text{mm}$. (25 hrs) (<i>Note down all dimensions and submit to instructor for verification</i>)</p> <p>24. Sawing different types of metals of different sections- round piece and Angle Iron. (10 hrs)</p> <p>25. Prepare mushroom head on round bar by hammering. (05 hrs)</p>	<p>Outside micrometer – its parts, principles, reading, uses and care, vernier height gauge. Marking tools – scribe, 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.</p>
6	-do-	<p>26. Make “S” bend by Hammering on flat piece. (06 hrs)</p> <p>27. Grinding of centre punch, dot punch, flat chisel and scribe. (08 hrs)</p> <p>28. Drill grinding practice. (05 hrs)</p> <p>29. Drill Centring Practice. (06 hrs)</p>	<p>Marking media, marking blue, Prussian blue, chalk and their special application, description. Surface plate and auxiliary marking equipment, ‘V’ block, angle plates, parallel block, description, types, uses, accuracy, care and maintenance.</p> <p>Bevel protractor, combination set- their components, uses and cares.</p>

			<p>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.</p> <p>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.</p>
7	-Do-	<p>30. Practice on measuring instruments. (08 hrs) 31. Job setting and tool setting on drilling machine. (04 hrs) 32. Chain drilling practice. (08 hrs) 33. Die passing practice. (05 hrs)</p>	<p>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</p> <ol style="list-style-type: none"> 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
8 - 10	<p>Make 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]</p>	<p>34. Make Male & Female ‘Open’ fitting with accuracy ± 0.05 mm. (35 hrs.) 35. Make Male & Female ‘Square’ fitting with accuracy ± 0.05 mm. (38 hrs.) 36. Scraping practice. (02 hrs.)</p>	<p>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 <i>Interpretation of ISO system of limits and fits.</i></p>

11	<p>Produce components involving different operations on Lathe, Milling and Grinding machines observing standard procedure and check for accuracy. (<i>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)</i>)</p>	<p>37. Identify different parts of lathe and demonstrate the operation of the machine. (04 hrs) 38. Job setting and tool setting. (04 hrs) 39. Facing and Centre drilling. (04 hrs) 40. Plain turning between centres and chamfering. (06 hrs) 41. Step turning and Shoulder turning. (07 hrs)</p>	<p>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.</p>
12	-do-	<p>42. Taper turning (compound rest). (08 hrs) 43. Grinding practice single point cutting tool (Straight, Left and Right) (08 hrs) 44. Plain turning in a chuck and Drilling practice. (09 hrs)</p>	<p>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, taper Turing and calculations, knurling, boring and step boring, Die passing. Cutting speed, Feed, depth of cut and time calculations</p>
13	-do-	<p>45. Knurling practice. (04 hrs) 46. Making a bolt and nut using external and internal thread cutting on Lathe. (16 hrs) 47. Taper measurement using Sine bar / Sine centre. (05 hrs)</p>	<p>Pedestal Grinding Machine- Constructional features- working principle-Purpose- function – uses and applications.</p>
14	-do-	<p>48. Identify different parts of milling machine and demonstrate the operation of the machine. (04 hrs) 49. Milling a parallel block. (08 hrs.) 50. Step milling. (04 hrs)</p>	<p>Milling Machine - Constructional features-working principle-Purpose-functions, Types and uses of accessories.</p>

		51. Making a T-nut (milling, drilling and tapping). (09 hrs)	Milling Operations- methods of milling, Plain milling, Step milling, end milling, machine time calculation.
15	-do-	52. Making one “V” block consists of plain milling, groove milling, taper milling and slot milling (25 hrs)	Milling Cutter- Purpose– types, Cutting tool Geometry, Nomenclature, Tool Life.
16	-do-	53. Pocket opening milling and matching (male and female). (08 hrs) 54. Straddle milling for making hexagonal head. (08 hrs) 55. Milling profiles and matching. (09 hrs)	Selection of coolants / cutting fluids for different materials. Cutting speed, Feed, depth of cut and time calculations. Fasteners: - Types- purpose and its Application.
17	-do-	56. Identify different parts of Surface Grinding Machine and demonstrate the operation of the machine. (05 hrs) 57. Grinding a parallel blocks. (10 hrs.) 58. Step grinding using surface grinding. (10 hrs)	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.
18	-do-	59. Identify different parts of Cylindrical Grinding Machine and demonstrate the operation of the machine. (02 hrs) 60. External plain cylindrical grinding. (07 hrs) 61. Step cylindrical grinding. (07 hrs) 62. Internal cylindrical grinding. (09hrs)	Grinding Wheel- specification –Grit-Grain size-Structure-Bond-Grades and selection of Grinding wheel - Dressing –Truing and balancing of Grinding wheel
19-20	Carryout different computer operation and trouble shoot. [Different computer operations: setting of computer & MS Office operation]	Practice of Basic Computer Operations 63. Draw sketches using paint for practice on mouse/touch pad. (02 hrs) 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. (04 hrs)

65. Settings of the control panel for Add/ remove hardware, Install/uninstall software, Change properties of peripheral devices, Connecting Projector. (08 hrs)

MS-Office

65. Practice on different menus and editing options of MS-Word. (06 hrs)
66. Create your resume in MS-Word. (03 hrs)
67. Create purchase order using tables and images. (03 hrs)
68. Create an invitation letter using mail merge for ‘n’ invitees. (03 hrs)
69. Practice on different menus and formulae options of Excel. (06 hrs)
70. Create mark sheet and chart using spread sheet with data validation. (03 hrs)

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. (02 hrs)
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. (10 hrs)	
21-22	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. (05 hrs) 67. Simple welding and brazing practice. (20 hrs) 68. Practice on tray brazing, die welding, welding on hardened die block. (25 hrs)	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.
23-25	Revision		
26	Examination		

Note: -

More emphasis to be given on video/real-life pictures during theoretical classes. Some real-life pictures/videos of automation and practical application of Mechatronics in complex operations etc., may be shown to the trainees to give a feel of Industry and their future assignment.

SYLLABUS FOR TECHNICIAN MECHATRONICS TRADE

Second Semester - Six Month

Week No.	Ref. Learning Outcome	Professional Skills (Trade Practical) With Indicative Hrs	Professional Knowledge (Trade Theory)
27-30	Construct different electrical sub-systems and measure parameters. <i>[Different electrical sub-systems: - AC/DC Motors, DC machine, DC motors, DC motor starter, Universal motor, Induction motor, AC drive, Servo drive, transformer.]</i>	<p>69. Measures to rescue a person from live wires. (03 hrs)</p> <p>70. Perform exercise to find out relationship between V, I, R and analyze the effect of short and open circuit in a circuit. (03 hrs)</p> <p>71. Check/Test the line, neutral and earth wires before connecting cable in to plugs. (02 hrs)</p> <p>72. From the given Electrical circuit/board familiarization with different types of plugs, sockets, switches, fuses and fuse holder. (03 hrs)</p> <p>73. Construct different DC sources by serial and parallel connection of batteries. (03 hrs)</p> <p>74. Ascertain different electrical instruments as per the drawings. (02 hrs)</p> <p>75. Measure the voltage and current in AC/DC Circuits using ammeter, voltmeter, and multi meter. (03 hrs)</p> <p>76. Measure power factor in poly-phase circuit using ammeter, voltmeter and wattmeter readings. (03 hrs)</p> <p>77. Construct series and parallel combination circuits and verify them. (03 hrs)</p> <p>78. Construct a simple circuit to test the operation of a Relay. (03 hrs)</p> <p>79. Measure input and output voltages in stabilizers, power supply unit in the control panel. (03 hrs)</p> <p>80. Application of test lamp and multi meter for identifying single and three phase supply. (03 hrs)</p>	<p>Basic electrical engineering Concepts 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.</p> <p>Electromagnetic theory: - Flux, Flux density, magnetic effect, magnetic field, electromagnetic force, concepts of coil (electromagnetic). Solenoids and relays.</p> <p>Instrument used for Measuring electrical parameters:- Measurements of electrical quantities using voltmeter , Ammeter, Multimeter, Megger. Power supply units and Stabilizers.</p> <p>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.</p> <p>Concepts of AC/DC Drives.</p> <p>Principle and operation of single phase, Three phase transformer and Auto transformer. Winding details of three phase transformer. Tacho Generator.</p> <p>Instrument transformers (CT and PT),</p>

	<ol style="list-style-type: none"> 81. Physical identification of Mechanical parts and winding details of AC/DC Motors. (03 hrs) 82. Develop work plan to test DC Machine winding continuity and insulation resistance. (04 hrs) 83. Construct and perform forward and Reverse operation of DC Motors. (06 hrs) 84. Construct and perform speed control of DC Motors. (03 hrs) 85. Connect, start, run and reverse of AC, single phase motor (inductive-start and capacitive-start). (05 hrs) 86. Control the speed of AC motor. (03 hrs) 87. Connect, Start, Run and reverse universal motor. (03 hrs) 88. Selections of accessories of a DOL starter, assemble, and run induction motor. (04 hrs) 89. Start, Run and reverse AC 3-phase motor using star-delta starter. (03 hrs) 90. Check the Motor speed and its line current using Tacho Generator and Clamp on meter. (03 hrs) 91. Configure AC drive for controlling induction motor. (03 hrs) 92. Configure DC drive for controlling DC motor. (03 hrs) 93. Construct a simple circuit to test positional and velocity control using Servo Drive. (04 hrs) 94. Exercise on positional accuracy using encoder. (03 hrs) 95. Exercise on positional accuracy using linear scale. (04 hrs) 96. Verify the terminals of 3-phase transformer HT and LT side. (03 hrs) 97. Measure Voltage and current of 1-Φ, 3-Φ Auto transformer. (03 hrs) 98. Measure phase sequence and 	<p>clamp meter, Phase sequence meter, Power factor meter.</p> <p>Concepts of open loop and closed loop systems, feedback devices used in Mechatronics, Principle and Operation of tacho-generator, Encoder, and linear scale.</p>
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		<p>power factor using phase sequence meter, power factor meter. (03 hrs)</p> <p>99. Measure the current of a given load using Tong-Tester. (03 hrs)</p>	
31-34	<p>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.]</p>	<p>100. Test the Electronic components using component tester and Multi meter, CRO and Test ICs using IC Tester. (04 hrs)</p> <p>101. Measure AC/DC parameters using CRO. (03 hrs)</p> <p>102. Construct Diode circuit and draw V-I characteristics. (03 hrs)</p> <p>103. Construct and test Half-wave, Full-wave and Bridge rectifier. (07 hrs)</p> <p>104. Construct Transistor Switch. (03 hrs)</p> <p>105. Construct Transistor Amplifier circuit. (04 hrs)</p> <p>106. Construct Zener regulator. (03 hrs)</p> <p>107. Construct transistor voltage regulator circuit. (04 hrs)</p> <p>108. Construct a 12/5 V DC power supply circuit. (04 hrs)</p> <p>109. Construct variable DC Regulated power supply. (07 hrs)</p> <p>110. Construct and verify basic op-amp circuits (Inverting, Non-inverting). (05 hrs)</p> <p>111. Construct comparator and Instrumentation Amplifier using Op-Amp. (07 hrs)</p> <p>112. Construct and Verify Photo LED circuit.(04 hrs)</p> <p>113. Construct and verify the operation of LDR and Photo diode. (04 hrs)</p> <p>114. Construct isolation circuit using opto-isolator. (05 hrs)</p> <p>115. Testing of SCR, DIAC, TRIAC, IGBT and UJT using Multimeter and component tester. (06 hrs)</p> <p>116. Construct a phase control rectifier circuits using SCRs. (08</p>	<p>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.</p> <p>Transistors and its applications.</p> <p>CRO-Block diagram and its functions.</p> <p>DC Regulated power supplies.</p> <p>Introduction to Op-Amp, characteristics, Configuration and its applications.</p> <p>Introduction to Opto-electronics, LED, LDR, Photo diode, opto-coupler.</p> <p>Study of Power Electronic Devices:</p> <p>Power diodes, power transistors, SCR, DIAC, TRIAC, UJT IGBT, phase control rectifiers, Converters.</p> <p>Soldering Techniques: -. Describe Soldering and De- soldering process, Do and Don'ts of soldering. Concepts of SMD.</p>

		<p>hrs)</p> <p>117. Construct and test UJT Relaxation oscillator. (03 hrs)</p> <p>118. Construct and test universal motor speed control by using SCR. (04 hrs)</p> <p>119. Practice Soldering and De-soldering on the PCBs for a given circuit(s). (12 hrs)</p>	
35-37	Estimate and perform panel wiring using cables, connectors, Protective devices and test functionality.	<p>120. Perform Termination of wires, cables and electronic components. (04 hrs)</p> <p>121. Perform Skinning, dressing, and joining for different types of cables.(06 hrs)</p> <p>122. Perform Crimping practice on RJ45, BNC, Audio, D-shell and Edge connectors. (07 hrs)</p> <p>123. Measure Insulation Resistance by using Megger. (03 hrs)</p> <p>124. Perform wiring in PVC conduit for power sockets controlled independently. (04 hrs)</p> <p>125. Perform wiring to control one lamp from different places. (04 hrs)</p> <p>126. Perform wiring to install buzzer, buttons, and protection alarm. (04 hrs)</p> <p>127. Prepare panel mains board with switch and distribution fuse box. (04 hrs)</p> <p>128. Estimate the materials for a given panel board connection plan. (04 hrs)</p> <p>129. Perform Wiring of power and control circuits in the panel board. (12 hrs)</p> <p>130. Measure earth resistance using earth tester. (03 hrs)</p> <p>131. Test the switches, pushbuttons,</p>	<p>Electrical cables and connectors:</p> <p>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.</p> <p>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.</p> <p>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,</p> <p>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. Environment safety and safety precautions while handling electrical equipments. Classification of fires, Different type of fire fighting</p>

		<p>limit switches, Foot pedal switch, Micro switches for its operation (08 hrs)</p> <p>132. Practice on working of protective elements such as MCB, OLR, ELCBs and fuses in power circuits. (08 hrs)</p> <p>133. Ascertain different safety symbols and signs used in workshop. (04 hrs)</p>	<p>equipments.</p>
38-39	Construct and verify different Digital Logic Circuits.	<p>134. Verify the truth table of AND, OR, NOT, NAND, NOR, XOR gates. (06 hrs)</p> <p>135. Construct and verify SR, JK, T and D Flip-Flops. (12 hrs)</p> <p>136. Construct and verify Binary counter, UP/DOWN counter circuits. (08 hrs)</p> <p>137. Construct and verify encoder and decoder circuits. (08 hrs)</p> <p>138. Construct Multiplexer and De multiplexer circuits. (04 hrs)</p> <p>139. Construct on Analog to Digital Converter (R-2R). (04 hrs)</p> <p>140. Digital to Analog converter (<i>Comparator, Dual slope, Successive approximation.</i>) (08 hrs)</p>	<p><u>Number System:</u></p> <p>Binary, Decimal, Octal, Hexa Decimal Number systems and its Conversions. Binary Arithmetic and logical operations.</p> <p><u>Digital Logic:</u></p> <p>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.</p>
40	Install different software in computer system and test. [<i>Different software: Office, Multimedia, Fluidsim, PLC, etc.</i>]	<p>Software Installation</p> <p>141. Prepare Hard disk for OS installation by making partitions. (02 hrs)</p> <p>142. Setup CMOS with desired parameters for hard disk and set date and time. (01 hr)</p> <p>143. Install Operating System Windows and Linux in two different partitions. (08 hrs)</p> <p>144. Install Device Drivers(Printers, Scanners, Xerox, audio), Install/Uninstall Application software (Office, Multimedia,</p>	<p>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 documents, spread sheet and presentation Explain and apply common prevention methods, Explain Service Flow Sequence (SFS) and Trouble Shooting Chart (TSC)</p>

		<p>Fluidsim, PLC and other simulation software) (06 hrs)</p> <p>145. Perform IT-supported fault diagnostics on systems and sub-systems within automation systems, identify, assign and check functions and components. (08 hrs)</p>	<p>of PC.</p> <p>Concept and need of</p> <ul style="list-style-type: none"> - Digitalization - Concept of Industry 4.0 <p>Introduction, working and Applications of</p> <ul style="list-style-type: none"> - RFID (Identification, system and application) - Bus (Binary unit system) Control - Information Security - GPS services
41	Write an assembly level programme and interface peripherals to 8051 Microcontroller to check functioning.	<p>146. Physically identify the components in 8051 trainer kit. (03 hrs)</p> <p>147. Write an program to perform arithmetic operations. (04 hrs)</p> <p>148. Write a program to perform exchange the memory location contents.(03 hrs)</p> <p>149. Interface LEDs to microcontroller and develop different patterns on it. (03 hrs)</p> <p>150. Interface switches and LEDs with microcontroller. (03 hrs)</p> <p>151. Interface buzzer to microcontroller. (03 hrs)</p> <p>152. Interface DC motor with microcontroller. (03 hrs)</p> <p>153. Interface stepper motor control with microcontroller. (03 hrs)</p>	<p>Basic block diagram of computer system. Block diagram of Microprocessor and its functionality. Difference between Microprocessor and Microcontroller.</p> <p>8051 Microcontroller-features, Block diagram and pin configuration. Assembler directives, Instruction set of 8051.Assembly language Programming.</p>
42-43	Trouble shoot and repair different Electrical, Electronic systems/ devices. [<i>Different Electrical, Electronic systems/ devices:- Fuse, MCB, Power circuit, Control panel, Circuit Breaker, Stabilizer, AC/DC drives.</i>]	<p>154. Replacement of fuses, Locating OLR and its resetting practice. (02 hrs)</p> <p>155. Locating faults in power circuit such as fuse blown, MCB Tripped, control fuse blown etc. (04 hrs)</p> <p>156. General checking of loose contacts in the control panel wirings. (04 hrs)</p> <p>157. Troubleshoot and Service a circuit breaker. (06 hrs)</p> <p>158. Service and troubleshoot the DC</p>	<p>Introduction to maintenance, Importance of maintenance and types. Guidelines for trouble shooting of electrical, electronic systems and PLC.</p>

		<p>motor starter. (04 hrs)</p> <p>159. Maintain, Service, and troubleshoot DC Machine. (06 hrs)</p> <p>160. Identify controls, trace the circuit and test the function of stabilizer. (06 hrs)</p> <p>161. Trouble shoot and maintenance of UPS and stabilizer. (08 hrs)</p> <p>162. Trouble shooting of AC/DC Drives. Check the feedback sensors. (10 hrs)</p>	
44-45	<p>Demonstrate function of different sensors. [<i>Different sensors: Proximity Sensors, inductive sensor, capacitive sensor, magnetic sensor, Reflex Photoelectric Sensors, Temperature Sensors, etc.</i>]</p>	<p>163. Behaviour of Proximity Sensors, inductive sensor, capacitive sensor, magnetic sensor. (06 hrs)</p> <p>164. Construct simple control circuit using Proximity sensor and reed switch and limit switch. (03 hrs)</p> <p>165. Identify Behaviour of Reflex Photoelectric Sensors. (02 hrs)</p> <p>166. Identify Behaviour of ultrasonic sensor. (02 hrs)</p> <p>167. Identify Behaviour of reed switch and limit switch. (03 hrs)</p> <p>168. Identify Behaviour of Temperature Sensors. (06 hrs)</p> <p>169. Identify Behaviour of Level Control. (06 hrs)</p> <p>170. Logical operation of sensors (06 hrs)</p> <p>171. Interface Sensors and Electrical Actuators. (08 hrs)</p> <p>172. Interface Sensors and Pneumatic Actuators. (08 hrs)</p>	<p>Introduction to Sensors & transducers</p> <p>Sensors - Classifications & Operation</p> <p>Proximity Sensor -Classifications & Operation</p> <p>Sensors for Temperature measurements</p> <p>Sensors for Distance and Displacement</p> <p>Sensor characteristics and interface technique</p>
46-48	Conveyor Control System (This can be used for 4th semester project.)		
49-51	Revision		
52	Examination		

Note: -

1. *Some of the sample project works (indicative only) are given against each semester.*
2. *Instructor may design their own project and also inputs from local industry may be taken for designing such new project.*
3. *The project should broadly covered maximum skills in the particular trade and must involve some problem solving skill. Emphasis should be on Teamwork: Knowing the*

power of synergy/ collaboration, Work to be assigned in a group (Group of at least 4 trainees). The group should demonstrate Planning, Execution, Contribution and application of Learning. They need to submit Project report.

- 4. If the instructor feels that for execution of specific project more time is required than he may plan accordingly to produce components/ sub-assemblies in appropriate time i.e., may be in the previous semester or during execution of normal trade practical.*
- 5. More emphasis to be given on video/real-life pictures during theoretical classes.*

SYLLABUS FOR TECHNICIAN MECHATRONICS TRADE

Third Semester - Six Month

Week No.	Ref. Learning Outcome	Professional Skills (Trade Practical) With Indicative Hrs	Professional Knowledge (Trade Theory)
53	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 (15 hrs) 173. Practice on co –ordinate systems, use of CNC codes (10 hrs)	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.
54	-do-	174. Tool Path practice in Absolute and Incremental Coordinate system. (15 hrs) 175. Practice On - Zero and Tool Offset and record of offset parameters in System. (10 hrs)	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.
55	-do-	176. Selection of Cutting speed, Feed, Depth of cut for CNC turning operations. (04 hrs) 177. Practice on Changing of tool holder and tool Inserts on CNC lathe. (04 hrs.) 178. Facing and plain turning. (08 hrs.) 179. Produce a component using CNC turning centre. (09 hrs)	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.

56-57	-do-	<p>180. Selection of cutting speed, feed, depth of cut for CNC milling operations. (06 hrs.)</p> <p>181. Practice on Changing of tool holder and tool Inserts on CNC Milling machine. (06 hrs)</p> <p>182. Program preparation for step milling and contour milling. (18 hrs)</p> <p>183. Produce a component using CNC milling centre with multiple operations. (20 hrs)</p>	<p>Calculations: Cutting speed, Feed, Depth of cut and machining time calculations.</p> <p>Tools and Tool holders for turning operations and milling operations.</p> <p>Simple programming for facing, plain turning, step turning operations and milling operations</p>
58	<p>Construct simple pneumatic control system to measure various parameters using transducer, sensor and switches. [Various parameter: pressure, flow, level of oil, load displacement]</p>	<p>184. Measure the level of oil using level switch (Magnetic Level) (03 hrs)</p> <p>185. Measurement of Load using Load cell. (02 hrs)</p> <p>186. Measurement of Displacement using LVDT. (03 hrs)</p> <p>187. Construct an open loop control system for pressure, temperature, flow and level. (08 hrs)</p> <p>188. Construct closed loop control system for pressure, temperature, flow and level. (09 hrs)</p>	<ul style="list-style-type: none"> • Definition and history of Pneumatic. Pneumatic system: <ol style="list-style-type: none"> 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.

59-60	Check various components of pneumatics system and construct pneumatic circuit to check functionality.	<p>189. Use logic valves and construct in pneumatic circuit. (08 hrs)</p> <p>190. Construct and perform the operation of Pressure control valves. (08 hrs)</p> <p>191. Using Time Delay valves perform the operation of pneumatic actuator. (06 hrs)</p> <p>192. Practice on Hydraulic and Pneumatic Simulation software. (14 hrs)</p> <p>193. Practice Hydraulic and Pneumatic Simulation software. (04 hrs)</p> <p>194. Prepare a Specification for various pneumatic elements (actuators, motors, valves and cylinders) of Lab/workshop. (10 hrs)</p>	<p>Types, constructions, designations, working, applications and selection criteria of following:</p> <ol style="list-style-type: none"> i. Directional control valves. ii. Flow control valves. iii. Pressure control valves. iv. Special valves- quick exhaust valve and time delay valve. v. Logic valves- shuttle valve and twin pressure valve. <p>Other fittings and access of Simulation Software for construction of Pneumatic circuits.</p> <p>Types of pneumatic fitting and their selections.</p> <p>Construction of pneumatic circuits using simulation software.</p> <p>Pneumatic cylinders- types, construction, working, materials, specifications, mounting and cushioning.</p> <p>Pneumatic motors- types, construction, working, specifications and applications.</p> <p>Referring machine manual and manufacturer's catalogue</p>
61	Construct an electro-pneumatic circuit and check functionality of a process. [E.g.- process: Automatic braking system.]	<p>195. Construct an electro pneumatic circuit for Automatic Brake system. (20 hrs)</p> <ol style="list-style-type: none"> 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 <p>196. Prepare a chart with ISO symbols</p>	<ul style="list-style-type: none"> • Pneumatic devices – concept and Importance. • Pneumatic Drives –I/P converter and P/I converter. <p>Electro-pneumatic circuits:</p> <ol style="list-style-type: none"> 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.

		and guiding rules for designing pneumatic system. (05 hrs)	Construction, working principle, major elements, performance variables and applications of following devices: <ul style="list-style-type: none"> i. Automotive pneumatic brake. ii. Automotive air suspension. iii. Pneumatic drill. iv. Pneumatic gun (tools).
62-63	Install and electro-pneumatic system and trouble shoot faults.	<p>197.</p> <p>a. Identify the parts of a two stage air compressor.</p> <p>b. Check oil level, Grade and adjustment of pressure in pressure switch.</p> <p>c. Air filter cleaning and replacement , Replacement of piston ring</p> <p>d. Gasket Checking and replacement</p> <p>e. Check the cooling system of air compressor</p> <p>f. Check and draw electrical power supply of compressor. (04 hrs)</p> <p>198. Install the FRL unit and check and adjusting the setting of pressure in pneumatics lines. (12 hrs)</p> <p>199. Conduct bearing maintenance. (04 hrs)</p> <p>200. Construct and Install an electro Pneumatic Pick and Place system, identify the various faults in the system and the remedial actions for them.(16 hrs)</p> <p>201. 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. (14 hrs)</p>	<ul style="list-style-type: none"> • 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). <p>Bearing and its functions</p> <p>Lubrication and their selections.</p> <ul style="list-style-type: none"> • Installation of pneumatic systems. • Causes, remedies and Troubleshooting in pneumatic elements. • Maintenance of pneumatic systems: <ul style="list-style-type: none"> i. Maintenance schedule and Inspection Check Sheet preparation ii. Maintenance of different application of Pneumatic system
64	Construct simple hydraulic circuit and check functionality.	202. Check of pressure built up and setting relief valve pressure in hydraulic system and checking of Line filter. (03 hrs)	Introduction and Definitions of important terms like Hydraulics, Pressure, Force, Vacuum etc. <ul style="list-style-type: none"> i. Pascal's Law and its

		<p>203. Tabulate the selection criteria of different grades of Hydraulic oil for the system. (02 hrs)</p> <p>204. Construct simple hydraulic circuit (16 hrs)</p> <ul style="list-style-type: none"> ▪ 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 <p>205. Practice on Hydraulic and Pneumatic Simulation software. (04 hrs)</p>	<p>Application of hydraulics</p> <ul style="list-style-type: none"> 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.
65	Demonstrate installation of accessories in hydraulic system and trouble shoot defects.	<p>206. Demonstrate Connection of Steel pipes, tubing and hose in Hydraulic line.(05 hrs)</p> <p>207. Installation of Pressure gauge /Indicator along with filter and strainer in Hydraulic system. (05 hrs)</p> <p>208. Fitting of different gaskets and seals in hydraulic line. (05 hrs)</p> <p>209. Installation and troubleshooting of hydraulic power pack. (10 hrs)</p>	<p>Types and Function of Components and Connectors</p> <ul style="list-style-type: none"> i) Steel pipe ii) Tubing iii) Hose iv) Gauges v) Packing and Seals vi) Filters and Strainers vii) Hydraulic Tank
66-67	Construct hydraulic circuit; verify various processes to assess functioning of valves	<p>210. Construct and perform the operation of Speed control of Hydraulic cylinder through Throttle valve. (03 hrs)</p>	<p>Construction, Types and working of :</p> <ul style="list-style-type: none"> • Directional Control Valves • Pressure Control Valves • Flow Control Valves

	<p>and auxiliaries. [Various processes: - speed control, lub system, press control etc.]</p>	<p>211. Construct and Perform of Speed control of Hydraulic cylinder through The Flow control valve in Bypass. (03 hrs)</p> <p>212. Construct and verify the functionality of Flow control valve in Meter-in and Meter-out circuit. (03 hrs)</p> <p>213. Construct and control Double acting pneumatic cylinder reciprocation by 3/2 push button valves and Shuttle Valve. (03 hrs)</p> <p>214. Construct and check the function of cartridge valves in Lubrication system. (10 hrs)</p> <p>215. Construct Electro Hydraulic circuit –Speed and Pressure control of double acting cylinder for hydraulic Press.(10 hrs)</p> <p>216. 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). (10 hrs)</p> <p>217. Practice on Hydraulic and Pneumatic Simulation software (08 hrs)</p>	<ul style="list-style-type: none"> ● Pressure Intensifiers ● Accumulators ● Cartridge Valves and Cylinder
68	<p>Install hydraulic pump, motors and carryout maintenance of these components.</p>	<p>218. Demonstrate the different types and working of Pumps using Cut-section Models. (03 hrs)</p> <p>219. Install Hydraulic Pump and Motor and verify its function in hydraulic power pack. (10 hrs)</p> <p>220. Maintenance of Hydraulic Motor and Pump for industry application. (12 hrs)</p> <p>i) Preparation of Maintenance Schedule</p> <p>ii) Preparation of inspection and</p>	<p>Construction and Working, Specifications :</p> <ul style="list-style-type: none"> ● Gear Pump ● Vane Pump ● Radial Piston Pump ● Pump Maintenance and Trouble Shooting , Hydraulic Motor Specifications ● Construction and Working of ● Gear Motor ● Vane Motor

		check sheet.	• Radial Piston Motor
69-70	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.]	221. Construct and verify One-Cycle Cylinder Reciprocation using limit switches, timer, Pushbutton and Single-Solenoid Valve and double solenoid valve. (06 hrs) 222. Construct and perform the operation of Accumulator Control Circuit. (06 hrs) 223. Construct and perform the deceleration and Oil filtration Circuit. (10 hrs) 224. Construct a hydraulic control circuit for clamping and de-clamping operation of part handling system. (10 hrs) 225. Construct and perform the operation of Hydraulic press control using hydraulic elements. (10 hrs) 226. Practice on Hydraulic and Pneumatic Simulation software. (08hrs)	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
71- 72	Programme PLC and interface with other devices to check its Applications.	227. Ascertain various modules, controls, and indicators of given PLC. (09 hrs) 228. Program and configure the PLC to perform a simple start/stop routine. (08 hrs) 229. Program the PLC using Timer and Counter instructions. (15 hrs) 230. Program the PLC to perform Move, Arithmetic, and Logical operations. (03 hrs) 231. Program the PLC for performing comparator operations. (3 hrs) 232. Practice on PLC wiring. (09 hrs) 233. Program PLC for controlling analog parameter(s). (03 hrs)	<u>PLC:</u> 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 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.
73-74	-Do-	234. Program a PLC for Traffic Light Control. (06 hrs) 235. Program PLC to generate different patterns for a given set of lights. (03 hrs) 236. Program a PLC for Reverse Forward Control of a Motor. (03 hrs) 237. Program a PLC for Conveyor Belt Motor Control. (05 hrs) 238. Program a PLC for parking system of 100 Cars. (04 hrs) 239. Program a PLC for motor Star-Delta Control. (03 hrs) 240. Program PLC for simple elevator control. (03 hrs) 241. Configuration of HMI. (05 hrs) 242. Interface I/O with PLC using Profibus system/ Ethernet. (02 hrs) 243. Interface PLC to pneumatic and hydraulic circuits. (04 hrs) 244. Resetting of major and minor errors in PLC. (06 hrs) 245. Troubleshooting of power supply and IO modules in PLC. (06 hrs)	Interfacing of PLC with other devices. Safety aspects. Introduction to HMI configuration.
75-76	In-plant training/ Project work		
	1. Bottle Filling System (PLC Based) 2. Paper cup making machine (Electro Pneumatic based) 3. J C B (Electro Pneumatic based)		
77	Revision		
78	Examination		

Note: -

1. *Some of the sample project works (indicative only) are given against each semester.*
2. *Instructor may design their own project and also inputs from local industry may be taken for designing such new project.*
3. *The project should broadly covered maximum skills in the particular trade and must involve some problem solving skill. Emphasis should be on Teamwork: Knowing the power of synergy/ collaboration, Work to be assigned in a group (Group of at least 4 trainees). The group should demonstrate Planning, Execution, Contribution and application of Learning. They need to submit Project report.*
4. *If the instructor feels that for execution of specific project more time is required than he may plan accordingly to produce components/ sub-assemblies in appropriate time i.e., may be in the previous semester or during execution of normal trade practical.*
5. *More emphasis to be given on video/real-life pictures during theoretical classes.*

SYLLABUS FOR TECHNICIAN MECHATRONICS TRADE

Fourth Semester - Six Month

Week No.	Ref. Learning Outcome	Professional Skills (Trade Practical) With Indicative Hrs	Professional Knowledge (Trade Theory)
79-80	Explain robot anatomy and perform programming robot using teach box, software.	246. Basic Functions of Teach Box (04 hrs) 247. Repositioning of Work pieces using Teach box. (09 hrs) 248. Exploring COSIMIR (Programming software) (04 hrs) 249. Simulation - Programming a Work cell and Downloading (08 hrs) 250. Teaching Mode in Programming software. (05 hrs) 251. On Line Mode in Programming software. (06 hrs) 252. Continuous Motion. (08 hrs) 253. Palletizing. (06 hrs)	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 tools. Robot Drives & Control, Robot Programming Languages, Robot Application in Manufacturing
81-83	Simulate the electrical circuits on simulation software and detect fault as per diagnostic procedure for Electrical system design.	254. Familiarisation with various features and components of Simulation software. (07 hrs) 255. Using and Testing of different types of Electrical components using Simulator. (08 hrs) 256. Develop Electrical circuit using simulator as per the drawing and test for its functionality. (20 hrs) 257. Develop Electrical circuit for any Industrial application using simulator software. (20 hrs) 258. Test the Electrical circuit developed in simulator, diagnose the fault, rectification, resetting of errors. (20 hrs)	Advantages of Simulator Software. Develop simple Electrical circuit Develop Industrial application based Electrical circuit Trouble shooting techniques and mechanism.
84-86	Simulate the electronic circuits on simulation software and detect fault as per diagnostic procedure for Electronics system	259. Familiarisation with various features and components of Simulation software. (7 hrs) 260. Using and testing of different types of Electronics components using Simulator. (8 hrs) 261. Develop Electronics circuit using simulator as per the drawing and	Advantages of Simulator Software. Develop simple Electronics circuit Develop Industrial application based Electronics circuit Trouble shooting techniques and

	design.	<p>test for its functionality. (20 hrs)</p> <p>262. Develop Electronics circuit for any Industrial application using simulator software. (20 hrs)</p> <p>263. Test the Electronics circuit developed in simulator, diagnose the fault, rectification, resetting of errors. (20 hrs)</p>	mechanism.
87-90	Simulate the Hydraulic and Pneumatic circuit on simulation software and detect fault as per diagnostic procedure for Hydraulics and Pneumatics system design.	<p>264. Practice Pneumatics fundamentals using simulation software. (12 hrs)</p> <p>265. Practice Electrical control of pneumatic system using simulation software. (14 hrs)</p> <p>266. Practice Hydraulic fundamentals using simulation software. (13 hrs)</p> <p>267. Practice Electrical control of hydraulic system using simulation software. (18 hrs)</p> <p>268. Develop Pneumatic circuit using simulator as per the drawing and test for its functionality. (18 hrs)</p> <p>269. Test the Hydraulic and Pneumatic circuit developed in simulator, diagnose the fault, rectification, resetting of errors. (25 hrs)</p>	<p>Advantages of Simulator Software.</p> <p>Develop simple Hydraulic circuit</p> <p>Develop simple pneumatic circuit</p> <p>Troubleshooting techniques and mechanism.</p>
91-100	Perform project work on Mechatronics (<i>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</i>)	<p>270. Preparation of mechanical drawing for picks and place project. (25 hrs)</p> <p>271. Preparation of Hydraulic and Pneumatic circuit diagram. (25 hrs)</p> <p>272. Preparation of Electrical wiring diagram. (25 hrs)</p> <p>273. Preparation of Electronics circuit diagram. (25 hrs)</p> <p>274. Prepare bill of material. (10 hrs)</p> <p>275. Perform Filing operation. (9 hrs)</p> <p>276. Perform drilling operation. (8 hrs)</p> <p>277. Perform Turning operation. (18 hrs)</p> <p>278. Perform Milling operation. (18 hrs)</p> <p>279. Perform surface finish operation. (04 hrs)</p>	<p>Application of Pick and Place project</p> <p>Function of each part</p> <p>Explanation of the drawings (Mechanical, Hydraulic, Pneumatic, Electrical)</p> <p>Assembling Techniques</p> <p>Safety precautions in each stage</p> <p>Testing procedure.</p> <p>Common faults and their rectification</p>

	<i>and repair. Safety measures in each stage)</i>	280. Assemble the Mechanical components as per drawing. (10 Hrs) 281. Assemble Hydraulic and Pneumatic circuit and interface. (13 hrs) 282. Assembling and wiring of Electrical and Electronic system integration. (10 hrs) 283. Develop, download PLC program and Integrate. (25 hrs) 284. Testing, Trouble shooting and Repairing. (25 hrs)	
101-103	Revision		
104	Examination		

NOTE:-

1. *Some of the sample project works (indicative only) are given against each semester.*
2. *Instructor may design their own project and also inputs from local industry may be taken for designing such new project.*
3. *The project should broadly covered maximum skills in the particular trade and must involve some problem solving skill. Emphasis should be on Teamwork: Knowing the power of synergy/ collaboration, Work to be assigned in a group (Group of at least 4 trainees). The group should demonstrate Planning, Execution, Contribution and application of Learning. They need to submit Project report.*
4. *If the instructor feels that for execution of specific project more time is required than he may plan accordingly to produce components/ sub-assemblies in appropriate time i.e., may be in the previous semester or during execution of normal trade practical.*
5. *More emphasis to be given on video/real-life pictures during theoretical classes.*

9. SYLLABUS - CORE SKILLS

9.1 WORKSHOP CALCULATION SCIENCE & ENGINEERING DRAWING

First Semester Duration: Six Months		
S No.	Workshop Calculation and Science	Engineering Drawing
1.	Units: Physical quantities and types, Fundamental and Derived units, Systems of units- FPS, CGS, MKS/SI unit, unit of length, Mass and time, Conversion of units.	Engineering Drawing: Introduction and its importance. Drafting Tools, Drawing Instruments - standards and uses Drawing board, Drafter (Drafting M/c), Set Squares, Protractor, Drawing Instrument Box (Compass, Dividers, Scales), Pencils of different Grades, Drawing pins / Clips. (1 session)
2.	Fractions : Fractions, Decimal fraction, L.C.M., H.C.F., Addition, Subtraction, Multiplication and Division of Fractions and Decimals, conversion of Fraction to Decimal and vice versa. Simple problems.	Lettering and Numbering as per BIS SP46-2003: Single Stroke, Inclined letters and numbers, Upper case and Lower case letters. (3 sessions)
3.	Square Root : Square and Square Root, method of finding out square roots, Simple problems.	Layout of Drawing Sheets Basic principle of Sheet Size, Designation of sizes, Selection of sizes Title Block, its position and content, Borders and Frames (Orientation marks and graduations) (2 sessions)
4.	Ratio and Proportion : Ratio, Proportion – types- direct and indirect. Simple calculation on related problems.	Lines: - Definition, types and applications in Drawing as per BIS SP:46-2003. Classification of lines (Object line, Hidden, centre, construction, Extension, Dimension, Section). Drawing lines of given length (Straight, curved), Drawing of parallel lines, perpendicular line. Methods of Division of line

		segment (3 sessions)
5.	Percentage: Introduction, Conversion of percentage to decimal and fraction and vice-versa. Loss and Profit. Simple and Compound interest. Simple calculations.	Drawing of Geometrical Figures: Practice of Angle-Measurement and method of bisecting. Triangle -different types. Rectangle, Square, Rhombus, Parallelogram. Circle (3 sessions)
6.	Material Science : Properties :-Physical and Mechanical, Metal Types –Ferrous and Non-Ferrous, difference between Ferrous and Non-Ferrous metals, introduction to Iron, Cast Iron, Wrought Iron, Steel, difference between Iron and Steel, Alloy steel, carbon steel, stainless steel, Non-Ferrous metals and Non-Ferrous Alloys.	Drawing of Geometrical Figures: Practice of Angle-Measurement and method of bisecting. Triangle -different types. Rectangle, Square, Rhombus, Parallelogram. Circle (3 sessions)
7.	Mass, Weight and Density : Mass, Unit of Mass, Weight, difference between mass and weight, Density, unit of density, specific gravity of metals. Archimedes’ principle.	Dimensioning: Definition, Systems of Dimensioning and methods of dimensioning (functional, non-functional and auxiliary) Types of arrowhead Leader Line with text (1 session)
8.	Speed and Velocity: Rest and motion, speed, velocity, difference between speed and velocity, acceleration, retardation, equations of motions, Newton’s laws of motion. Simple related problems.	Free hand drawing of Lines, polygons, ellipse, etc. geometrical figures and blocks with dimension Transferring measurement from the given object to the free hand sketches. (2 sessions)
9.	Work, Power and Energy: Work, unit of work, power, unit of power, Horse power, mechanical efficiency, energy, use of energy, potential and kinetic energies, examples of potential energy and kinetic	Symbolic Representation (as per BIS SP:46-2003) of : - Conversional representation of threads - Fastener (Rivets, Bolts and Nuts)

	energy. Simple related problems.	Construction of scales (enlarged and reduced) (2 sessions)
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Second Semester		
Duration: Six Months		
S No.	Workshop Calculation and Science	Engineering Drawing
1.	Algebra : Addition, Subtraction, Multiplication, Division, Algebraic formula, Simple equations, Quadratic equations, Simultaneous equations (with two variables). Simple problems.	Drawing of Solid figures (Cube, Cuboids, Cone, Prism, Pyramid, Frustum of Cone and Pyramid.) with dimensions. (3 sessions)
2.	Mensuration : Plane and Solid. Area and perimeter of triangle, square, rectangle, parallelogram, trapezium, polygons. Simple problems on regular and combined plane figures.	Construction of Different Polygons-Pentagon, Hexagon, Heptagon, Octagon. Inscribed and Circumscribed polygons. Conic sections (Circle, Ellipse, Parabola and Hyperbola) (4 sessions)
3.	Trigonometry : Trigonometrical ratios, measurement of angles. Value of trigonometric function for frequently used angles. Compound, multiple and submultiple angles. Use of Trigonometric tables.	Method of presentation of Engineering Drawing <ul style="list-style-type: none"> - Pictorial View - Orthogonal View - Isometric view (2 sessions)
4.	Heat and Temperature : Heat and temperature, their units, difference between heat and temperature, boiling point, melting point, scales of temperature measurement, relation between different scale of temperature, Thermometer, pyrometer, transmission of heat. Methods of heat transmission - conduction, convection, radiation. Simple problems.	Projections: <ul style="list-style-type: none"> - Concept of axes plane and quadrant. - Orthographic projections - Method of first angle and third angle projections (definition and difference) - Symbol of 1st angle and 3rd angle projection as per IS specification. (2 sessions)
5.	Simple Machines : lever and types with examples. Simple Machine, Effort and Load, input, output, Mechanical Advantage, Velocity Ratio, Efficiency of machine and	- Construction of Isometric drawings from the given orthographic views (3 sessions)

	Relationship. Simple problems.	
6.	Lubricants: Function, theories of friction, mechanism of lubrication - thick film, thin film and extreme pressure. Classification - solid, liquid and semisolid, Properties - viscosity, flash point and fire point, cloud and pour point, aniline point, corrosion stability.	Drawing of Orthographic projection from isometric/3D view of blocks in third angle projection method (2 sessions)
7.	Basic Electricity: Introduction, use of electricity, how electricity is produced, Electric current - AC, DC, their comparison, voltage, resistance, their units. Conductor, insulator, Ohm's Law. Types of connections – series, parallel and combined. Electric power, Horse power, energy, unit of electrical energy-kWh. Simple problems.	Drawing of Orthographic projection from isometric/3D view of blocks in first angle projection method (2 sessions)
8.	Basic electronics:- Electron theory, Semiconductors, diodes, Transistors: PNP, NPN, Triode.	Sectional Views – Full section- half section – exercises (2 sessions) Drawing details of two simple mating blocks and assembled view. (1 session)
9.	Number system:- Introduction, Decimal, binary, octal, hexadecimal BCD code, ASCII code, Bit, Byte, KB, MB, GB conversion.	Missing views of simple solid objects (1 session)

Third Semester		
Duration: Six Months		
S No.	Workshop Calculation and Science	Engineering Drawing
1.	Revision of first year topics. Heat treatment processes.	ELECTRONICS SYMBOLS (6 hrs) 1) Basic Symbols 2) Diode ,Rectifiers, Thyristors PRACTICING CIRCUITS USING SYMBOLS (6hrs) 1) Regulator Circuit 2) Combinational Clipper Circuit 3) Timer circuit (4 sessions)
2.	Area of cut-out regular surfaces: circle and segment and sector of circle.	ELECTRICAL SYMBOLS(3 hrs) 1) Inductor symbol 2) Meter symbol 3) Lamp/light symbol PRACTICING CIRCUITS USING SYMBOLS (6 HRS) 1) Open circuit test for single phase transformer 2) Working of DC motor (3 sessions)
3.	Area of irregular surfaces. Application related to shop problems.	DIGITAL ELECTRONICS SYMBOLS (3 hrs) 1) Logic Gates Symbols PRACTICING CIRCUITS USING SYMBOLS (3 hrs) 1) Flip flop Circuit (2 sessions)
4.	Volume, Lateral surface area and total surface area of solids – cube, cuboid, prism, cylinder, cone, Sphere. Simple problems on regular and combined solids Volume of cut-out solids: hollow cylinders, frustum of cone, block section. Volume of simple machine blocks.	1 SENSOR SYMBOLS (3 hrs) 2 PRACTICING CIRCUITS USING SYMBOLS (3 hrs) (2 sessions)
5.	Area of triangle. Sine rule and Cosine rules. Finding the value of unknown sides	PNEUMATICS(9HRS)

	and angles of a triangle by Trigonometrical method. Angle of Elevation and Angle of Depression. Heights and distances. Simple problems.	<ol style="list-style-type: none"> 1. Pneumatic symbols 2. Actuation of SAC 3. Speed control of SAC 4. Actuation of DAC 5. AND 6. OR operation 7. Combination Circuit- <p>(3 sessions)</p>
6.	Finding height and distance by trigonometry.	<p>ELECTRO PNEUMATICS(9HRS)</p> <ol style="list-style-type: none"> 1. Electrical symbols in Pneumatics 2. Direct actuation of cylinders 3. Indirect actuation of cylinders 4. Sequencing <p>(3 sessions)</p>
7.	Application of trigonometry in shop problems. (viz. taper angle calculation).	<ol style="list-style-type: none"> 1. HYDRAULIC AND ELECTRO HYDRAULIC SYMBOLS 3HRS 2. PRACTICING HYDRAULIC CIRCUITS (6 HRS) <p>(3 sessions)</p>
8.	Forces definition. -Compressive, tensile, shear forces and simple problems. Stress, strain, ultimate strength, factor of safety. Basic study of stress-strain curve for ductile metal. -Simple problems.	
9.	Temperature measuring instruments. Specific heats of solids and liquids. Thermal Conductivity, Heat loss and heat gain.	
10.	Circular Motion:- Relation between circular motion and Linear motion, Centrifugal force, Centripetal force	

Fourth Semester		
Duration: Six Months		
S No.	Workshop Calculation and Science	Engineering Drawing
1.	<p>Graph:</p> <ul style="list-style-type: none"> - Read images, graphs, diagrams - bar chart, pie chart. - Graphs: abscissa and ordinates, graphs of straight line, related to two sets of varying quantities. 	<ol style="list-style-type: none"> 1. Detailed part drawings of the project (Pick and Place) indicating surface roughness values, tolerances and relevant fits. 2. Assembly drawing of the project. 3. Prepare the bill of material. 4. Functional drawing (line drawing) 5. Circuit drawing for pneumatic system. 6. PLC program sheet
2.	<p>Simple problem on Statistics:</p> <ul style="list-style-type: none"> - Frequency distribution table - Calculation of Mean value. - Examples on mass scale productions. -Cumulative frequency -Arithmetic mean 	
3.	Acceptance of lot by sampling method (within specified limit size) with simple examples (not more than 20 samples).	
4.	<p>Friction- co-efficient of friction, application and effects of friction in Workshop practice.</p> <p>Centre of gravity and its practical application.</p>	
5.	<ul style="list-style-type: none"> - Magnetic substances- natural and artificial magnets. - Method of magnetization. Use of magnets. 	
6.	<ul style="list-style-type: none"> - Electrical insulating materials. - Basic concept of earthing. 	
7.	<ul style="list-style-type: none"> - Transmission of power by belt, pulleys and gear drive. - Calculation of Transmission of power by belt pulley and gear drive. 	
9.	Concept of pressure – units of pressure, atmospheric pressure, absolute pressure, gauge pressure – gauges used for measuring pressure	
10.	<p>Estimation and costing:-</p> <p>Calculation of weight of material, material cost , machining cost, labour cost and total cost</p>	

9.2 EMPLOYABILITY SKILLS

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

and Internet	Local Area Network (LAN), Wide Area Network (WAN), Internet, Concept of Internet (Network of Networks), Meaning of World Wide Web (WWW), Web Browser, Web Site, Web page and Search Engines. Accessing the Internet using Web Browser, Downloading and Printing Web Pages, Opening an email account and use of email. Social media sites and its implication. Information Security and antivirus tools, Do's and Don'ts in Information Security, Awareness of IT - ACT, types of cyber crimes.
3. Communication Skills	
Duration: 15 Hrs. Marks : 07	
Introduction to Communication Skills	Communication and its importance Principles of Effective communication Types of communication - verbal, non verbal, written, email, talking on phone. Non verbal communication -characteristics, components-Para-language Body language Barriers to communication and dealing with barriers. Handling nervousness/ discomfort.
Listening Skills	Listening-hearing and listening, effective listening, barriers to effective listening guidelines for effective listening. Triple- A Listening - Attitude, Attention & Adjustment. Active Listening Skills.
Motivational Training	Characteristics Essential to Achieving Success. The Power of Positive Attitude. Self awareness Importance of Commitment Ethics and Values Ways to Motivate Oneself Personal Goal setting and Employability Planning.
Facing Interviews	Manners, Etiquettes, Dress code for an interview Do's & Don'ts for an interview.
Behavioral Skills	Problem Solving Confidence Building Attitude
Second Semester	
4. Entrepreneurship Skills	
Duration : 15 Hrs. Marks : 06	
Concept of	Entrepreneur - Entrepreneurship - Enterprises:-Conceptual issue

Entrepreneurship	Entrepreneurship vs. management, Entrepreneurial motivation. Performance & Record, Role & Function of entrepreneurs in relation to the enterprise & relation to the economy, Source of business ideas, Entrepreneurial opportunities, The process of setting up a business.
Project Preparation & Marketing analysis	Qualities of a good Entrepreneur, SWOT and Risk Analysis. Concept & application of PLC, Sales & distribution Management. Different Between Small Scale & Large Scale Business, Market Survey, Method of marketing, Publicity and advertisement, Marketing Mix.
Institutions Support	Preparation of Project. Role of Various Schemes and Institutes for self-employment i.e. DIC, SIDA, SISI, NSIC, SIDO, Idea for financing/ non financing support agencies to familiarizes with the Policies /Programmes & procedure & the available scheme.
Investment Procurement	Project formation, Feasibility, Legal formalities i.e., Shop Act, Estimation & Costing, Investment procedure - Loan procurement - Banking Processes.
5. Productivity	
Duration : 10 Hrs.	
Marks : 05	
Benefits	Personal / Workman - Incentive, Production linked Bonus, Improvement in living standard.
Affecting Factors	Skills, Working Aids, Automation, Environment, Motivation - How improves or slows down.
Comparison with developed countries	Comparative productivity in developed countries (viz. Germany, Japan and Australia) in selected industries e.g. Manufacturing, Steel, Mining, Construction etc. Living standards of those countries, wages.
Personal Finance Management	Banking processes, Handling ATM, KYC registration, safe cash handling, Personal risk and Insurance.
6. Occupational Safety, Health and Environment Education	
Duration : 15 Hrs.	
Marks : 06	
Safety & Health	Introduction to Occupational Safety and Health importance of safety and health at workplace.
Occupational Hazards	Basic Hazards, Chemical Hazards, Vibroacoustic Hazards, Mechanical Hazards, Electrical Hazards, Thermal Hazards. Occupational health, Occupational hygienic, Occupational Diseases/ Disorders & its prevention.
Accident & safety	Basic principles for protective equipment. Accident Prevention techniques - control of accidents and safety

	measures.
First Aid	Care of injured & Sick at the workplaces, First-Aid & Transportation of sick person.
Basic Provisions	Idea of basic provision legislation of India. safety, health, welfare under legislative of India.
Ecosystem	Introduction to Environment. Relationship between Society and Environment, Ecosystem and Factors causing imbalance.
Pollution	Pollution and pollutants including liquid, gaseous, solid and hazardous waste.
Energy Conservation	Conservation of Energy, re-use and recycle.
Global warming	Global warming, climate change and Ozone layer depletion.
Ground Water	Hydrological cycle, ground and surface water, Conservation and Harvesting of water.
Environment	Right attitude towards environment, Maintenance of in -house environment.
7. Labour Welfare Legislation	
	Duration : 05 Hrs. Marks : 03
Welfare Acts	Benefits guaranteed under various acts- Factories Act, Apprenticeship Act, Employees State Insurance Act (ESI), Payment Wages Act, Employees Provident Fund Act, The Workmen's compensation Act.
8. Quality Tools	
	Duration : 10 Hrs. Marks : 05
Quality Consciousness	Meaning of quality, Quality characteristic.
Quality Circles	Definition, Advantage of small group activity, objectives of quality Circle, Roles and function of Quality Circles in Organization, Operation of Quality circle. Approaches to starting Quality Circles, Steps for continuation Quality Circles.
Quality Management System	Idea of ISO 9000 and BIS systems and its importance in maintaining qualities.
House Keeping	Purpose of House-keeping, Practice of good Housekeeping.
Quality Tools	Basic quality tools with a few examples.

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

21	Tweezers		20 nos
22	Knife	100mm	20 nos
23	Wire Stripper		20 nos
24	Neon Tester		20 nos
25	Scissors	150mm	20 nos
26	Soldering iron	25watts	20 nos
27	Bread Board		20 nos
B: TOOLS AND EQUIPMENTS:			
1	Caliper outside	150mm	4 nos
2	V-block	50 mm X 100mm and 75 mm X 100 mm each	2Nos
3	Divider – 150 mm		4 Nos
4	Screw driver	150 mm and 200mm each	4Nos
5	Circlip plier (inside and outside) each		4Nos
6	Centre gauge	55 ⁰ and 60 ⁰	4 Nos
7	Oil can		4 No.
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 sets

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	4Nos
27	Cast Iron Surface plate	300 x 300 mm	1Nos
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	20 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, 20-22, 24-26 (8-spanners)	2 sets
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	4Nos
67	Ammeter	0 – 1 Amp DC	3Nos
68	Voltmeter	0 – 300/600V AC	4Nos
69	PF Meter		5Nos
70	Phase Sequence Meter		4Nos
71	Digital multi Meter	2.5 Amps / 5Amps	5Nos
72	Energy meter, Single / Three phase		4 Nos
73	Clamp on meter	0 – 50 Amps	5Nos
74	Ammeter portable type	0 – 15 Amps AC	4Nos
75	Test lamp		3Nos
76	Tong-Tester		4Nos
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 no.
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	(350V)	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 no.
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	1 no.
6	C.R.O , 50 M Hz		4 nos.
7	Digital and Analog IC Tester		01 each
8	Digital Tachometer		2 nos.
9	Signal Generator		5 nos.
10	DC Power supply unit	0 - 30 v , 2 Amps	5 nos.
11	Digital Earth Tester		2 Nos.
12	Firefighting equipment		3 Nos.
13	Linear IC Trainer Kit		1No
14	AC / DC Motor speed control trainer kit		1No each
15	Optical Transducer Trainer kit.		4 Nos.
16	Simple Servomotor trainer kit.		2 Nos.
17	Simple stepper motor trainer kit.		2 Nos.
18	Linear scale setup for positional accuracy check		3 Nos.
19	A/D and D/A Trainer kit		1No
20	UPS and Stabilizer Trainer kit		1No each
21	AC Drive		4 Nos.

22	DC Drive		2 Nos.
23	Digital circuits trainer Kit.		2 Nos.
24	8051 Microcontroller trainer board with LED, Switches, Buzzer, DC motor and Stepper motor interfacing circuits.		3 Nos.
25	PLC with IO simulation panel and programming software with PLC application module		1No
26	Ethernet to Profibus converter		5Nos
27	HMI		1 Nos.
28	Personal Computers (latest version)		10 Nos.
29	Operating system (Windows latest version)		10 Users
30	Portable Hard Disk.(1 TB)		1No
31	MS-Office		10 Users.
32	RJ45,BNC,D-Shell, Edge Connector Crimping Tool		2 Nos. each
33	Megger		3 Nos.
34	Encoder Trainer Kit		3 Nos.
35	Panel Wiring Work bench		5Nos
36	Protection Devices Trainer Board.		1 Nos.
37	Limit switch, Pressure switch, Micro switch, Float switch, Foot switch		10 Nos.
38 *	Application trainer kit of proximity sensor, float switch, and reed switch.		1No
39	LVDT Trainer kit.		5 Nos.
40	Actuators Application Trainer(Servo, stepper motor, and Solenoid)		1 No
41	Optical Transducer Trainer kit.		4 Nos.
42	Simple Servomotor trainer kit.		2 Nos.
43	Simple stepper motor trainer kit.		2 Nos.

44	Piezoelectric transducer/actuator trainer kit.		2 Nos.
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 with required components.		5 Nos.
48 *	Electro-Hydraulic control trainer kit with required components.		1 No
49 *	Electro-Pneumatic control trainer kit using PLC with required components.		4 Nos.
50 *	Electro-Hydraulic control trainer kit using PLC with required components.		2 Nos.
51 *	Linear scale setup for positional accuracy check		2 Nos.
52 *	PLC Based Conveyor System with Pick and Place and Sorting of Objects (Pneumatic and Hydraulic))		2 Nos.
53 *	Cut section Models of Pneumatic and Hydraulic Motors ,Pumps		Each 1 no.
54 *	Electrical simulator software		10 users license
55 *	Electronic simulator software		10 users license
56 *	Hydraulics and Pneumatics simulator software		10 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

1.	Sensitive drilling machine	Capacity 12 mm Motorized –with drill chuck and key with Standard and optional accessories.	1No.
2.	Pillar/column type Drilling machine	25 mm capacity-motorized with drill chuck and Key with Standard and optional accessories.	1No.
3.	Power hacksaw machine	21” or more length blade with Standard	1 No.

		and optional accessories.	
4.	Double ended Pedestal Grinder	178 mm wheels(one fine and one rough wheel)	2 Nos.
5.	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	2 Nos.
6.	Shearing machine (lever type) hand operated complete	300 mm blade length.	1 No.
7.	Universal Milling Machine	Standard and optional accessories and set of cutters.	2Nos.
8.	Horizontal and Vertical milling machine	Standard and optional accessories and set of cutters each.	1 Set
9.	Hydraulic Surface Grinding Machine	standard and optional accessories and set of wheels	2 Nos.
10.	Universal cylindrical grinding machine	Standard and optional accessories and set of wheels.	2 Nos.
11.	CNC turn Centre	[specification as per Annex-A (I)]	1 No.
12.	CNC Vertical Machining Centre	[specification as per Annex-A (II)]	1 No.
13.	Drafting /AutoCAD software	Latest version	10 license
14.	Mechanical parametric Design /Creo (proE) software		10 license
15.	<p>Simulation software</p> <p>Multimedia based simulator for CNC technology and interactive CNC part programming software for turning & milling with virtual machine operation and simulation using popular operation control system such as Fanuc, Siemens, etc. (Web-based or licensed based)</p> <p>With help of this software the trainees should be able to Write, Edit, Verify & Simulate</p>		10 license (can be used by other trades)

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. 43**.*
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.***

TOOLS &EQUIPMENTS FOR EMPLOYABILITY SKILLS		
S No.	Name of the Equipment	Quantity
1.	Computer (PC) with latest configurations and Internet connection with standard operating system and standard word processor and worksheet software	10 nos.
2.	UPS - 500VA	10 nos.
3.	Scanner cum Printer	1 no.
4.	Computer Tables	10 nos.
5.	Computer Chairs	20 nos.
6.	LCD Projector	1 no.
7.	White Board 1200mm x 900mm	1 no.
<p><i>Note: Above Tools &Equipments not required, if Computer LAB is available in the institute.</i></p>		

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/DROPACO				
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				

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/DROPKO				
h	Coolant Pump	RAJAMANE/GRU NDFOS				
i	Cutting tools and holders	SANDVIK/TAEGUTEC/KEN NAMETAL/SECO/MITSUBISHI				
j	Air compressor (capacity:6 kg/cm ² - 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				

FORMAT FOR INTERNAL ASSESSMENT

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