

**Syllabus for the trade**

**of**

**MECHANIC MECHATRONICS  
(FITTING & MEASUREMENT)  
(SEMESTER PATTERN)**

**Under**

**CRAFTSMAN TRAINING SCHEME (CTS)**

**Designed in: 2013**

**By**

**Government of India  
Ministry of Labour & Employment  
Directorate General of Employment & Training  
CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE  
Block - EN - 81 SECTOR – V, SALT LAKE CITY,  
KOLKATA – 700 091**

**List of members of Trade Committee meeting for the  
trade of “MECHANIC MECHATRONICS” Held at ATI, Chennai**

<b>Sl. No.</b>	<b>Name &amp; Designation</b>	<b>Representing Organisation</b>	<b>Remarks</b>
1	Shri A. Mahendran , Director	ATI, Chennai -32	Chairman
2	Shri S.Harinath Babu, Joint Director of Training	ATI, Chennai -32	Member
3	Shri Sakthi Ganesan, DDT,	ATI, Chennai -32	Member
4	Shri P.Marvel Doss ADT,	ATI, CHENNAI	Member
5	Shri M.Rajeswari, ADT	ATI, CHENNAI	Member
6	Shrri. N.P.Bannibagi, TO	ATI, CHENNAI	Member
7	Shri. E.Vinoth Kannan Joint Manager- Maintenace,	COBOT SANMAR LIMITED, SALEM	Member
8	Shri S.Madhivanan, Vice President	SANMAR GROUP-CHENNAI	Member
9	Shri S.Chandra Sekar, Senior Faculty	CHRISTAINE SHARPLINE TECHNOLOGIES-MUMBAI	Member
10	Shri L.K Mukherjee, DDT	CSTARI, KOLKATA	Member
11	Shri S.B.Sardar, ADT	CSTARI, KOLKATA	Member
12	Shri S.Dillirajan, Sr.Section Engineer	LOCO WORKS, CHENNAI	Member
13	Shri K.Ravindranath, A.T.O	GOVT. ITI,AMBATTUR, CHENNAI	Member
14	Shri R. Ravichandran, T.O	GOVT. ITI,AMBATTUR, CHENNAI	Member
15	Shri K. Vijayalakshmi, T.O	GOVT. ITI,NORTH CHENNAI	Member
16	Shri K. Amarasen, A.T.O	GOVT. ITI, GUINDY, CHENNAI	Member

**List of members attended the Workshop to finalize the syllabi of existing CTS into Semester Pattern held from 6<sup>th</sup> to 10<sup>th</sup> May'2013 at CSTARI, Kolkata.**

<b>Sl. No.</b>	<b>Name &amp; Designation</b>	<b>Organisation</b>	<b>Remarks</b>
1.	R.N. Bandyopadhyaya, Director	CSTARI, Kolkata-91	Chairman
2.	K. L. Kuli, Joint Director of Training	CSTARI, Kolkata-91	Member
3.	K. Srinivasa Rao, Joint Director of Training	CSTARI, Kolkata-91	Member
4.	L.K. Mukherjee, Deputy Director of Training	CSTARI, Kolkata-91	Member
5.	Ashoke Rarhi, Deputy Director of Training	ATI-EPI, Dehradun	Member
6.	N. Nath, Assistant Director of Training	CSTARI, Kolkata-91	Member
7.	S. Srinivasu, Assistant Director of Training	ATI-EPI, Hyderabad-13	Member
8.	Sharanappa, Assistant Director of Training	ATI-EPI, Hyderabad-13	Member
9.	Ramakrishne Gowda, Assistant Director of Training	FTI, Bangalore	Member
10.	Goutam Das Modak, Assistant Director of Trg./Principal	RVTI, Kolkata-91	Member
11.	Venketesh. Ch. , Principal	Govt. ITI, Dollygunj, Andaman & Nicobar Island	Member
12.	A.K. Ghate, Training Officer	ATI, Mumbai	Member
13.	V.B. Zumbre, Training Officer	ATI, Mumbai	Member
14.	P.M. Radhakrishna pillai, Training Officer	CTI, Chennai-32	Member
15.	A.Jayaraman, Training officer	CTI Chennai-32,	Member
16.	S. Bandyopadhyay, Training Officer	ATI, Kanpur	Member
17.	Suriya Kumari .K , Training Officer	RVTI, Kolkata-91	Member
18.	R.K. Bhattacharyya, Training Officer	RVTI, Trivandrum	Member
19.	Vijay Kumar, Training Officer	ATI, Ludhiana	Member
20.	Anil Kumar, Training Officer	ATI, Ludhiana	Member
21.	Sunil M.K. Training Officer	ATI, Kolkata	Member
22.	Devender, Training Officer	ATI, Kolkata	Member
23.	R. N. Manna, Training Officer	CSTARI, Kolkata-91	Member
24.	Mrs. S. Das, Training Officer	CSTARI, Kolkata-91	Member
25.	Jyoti Balwani, Training Officer	RVTI, Kolkata-91	Member
26.	Pragna H. Ravat, Training Officer	RVTI, Kolkata-91	Member
27.	Sarbojit Neogi, Vocational Instructor	RVTI, Kolkata-91	Member
28.	Nilotpala Saha, Vocational Instructor	I.T.I., Berhampore, Murshidabad, (W.B.)	Member
29.	Vijay Kumar, Data Entry Operator	RVTI, Kolkata-91	Member

## GENERAL INFORMATION

1. Name of the Trade : **MECHANIC MECHATRONICS.**
2. N.C.O. Code No. : 845.63
3. Duration : 2 Years (Four Semesters having duration of six months each)
4. Power norms : 8.0 KW
5. Space norms : 192 Sq. Mt.
6. Entry Qualification : Passed 10th class examination under 10+2 system of education with Science and Mathematics or its equivalent.
7. Unit Size (No. of Student) : 16
- 8a. Instructor's/Trainer's Qualification : Degree in Mechanical Engineering from recognized Engineering college/university with one year experience in the relevant field
- OR
- Diploma in Mechanical Engineering from recognized board of technical education with two years experience in the relevant field
- OR
- 10<sup>th</sup> Class Passed & NTC/NAC in the Trade of "Mechanic Mechatronics" with 3 years post qualification experience in the relevant field.
- 8b. Desirable Qualification : Preference will be given to a candidate with Craft Instructor Certificate.

Note: At least one Instructor must have Degree/Diploma in Marine/Mechanical Engg

## Syllabus for the Trade of “MECHANIC MECHATRONICS”

### Under Craftsman Training Scheme

(Semester Code no. MMC - 01)

Duration : Six Month

### **Semester-I (Fitting & Measurement)**

Week No.	Practical	Trade Theory	Engineering Drawing	Workshop Science & Calculation
01	History of Institute – necessary information, guidance to the new corner to get familiarize with the working institute, rules, procedures etc. Recreational, Medical & other facilities available in the institute. Familiarization with institute & work place. Scope & Importance of the Trade Training, Types of the work done by the Trainee & role of “MECHANIC MECHATRONICS” in an industry. Rules & regulations of the institute. Allocation of workplace. Issue of tool box & essential tools. Importance of Cleanliness & orderliness at the workplace.			
02	General Safety Rules. Introduction to First Aid practices- Method of Maintaining First Aid Box. Fire Fighting equipment & their uses. (Shop talk & demonstration). Familiarization with various hand tools used in the trade. Introduction to bench vice, its construction, operation, maintenance & Lubrication.	Importance of safety, accidents & Causes of Accidents. General Safety, Precautions & personal safety to be observed while working in the institute/ sections. Safe working habits, importance of good housekeeping, cleanliness, General Safety Precautions & personal safety to be observed while working in the institute/ sections. Safe working habits, importance of good housekeeping, cleanliness & orderliness & personal hygiene. Importance of the Trade in the industrial economy of the country. What is related instructions- subjects to be taught, achievement to be made etc.	Introduction to graphical language and use of drawing instruments.	Definition of Force & Momentum Composition & Resolution of forces ,Lami’s Theorem, condition of Equilibrium.
03	Preparation for filing. Gripping the job suitably in the Vice jaws for filing. Taking correct standing posture with respect to bench vice for filing. Balancing of File. Filing To the marked lines using rough file. Use	Introduction to measuring & checking instruments. Non-precision linear measurement by using steel rule, depth rule, hook rule & zigzag rule, bit rule, tape etc. Measurement by using firm joint caliper, spring joint caliper, adjustable bevel protractor & combination set etc.	BIS standard size drawings sheet. Free hand sketching practice of horizontal and vertical lines. Lettering practice inclined style as per	Parallelogram of law of forces. Triangle law of forces. Calculation of least count on vernier caliper & micrometer

	<p>of simple measuring instruments such as Steel Rule, Vernier caliper, inside/outside Micrometer. Care and precautions to be observed in handling these instruments.</p> <p>Measurement by using inside/outside calipers and scales.</p> <p>Exercises on measurement of various geometrical shapes.</p> <p>Exercise on making lines on the work piece according to simple blue prints, using marking tools such as steel rule, scribe, marking blocks &amp; driver.</p> <p>Scribing lines on chalked or coloured (blue) surfaces of the work piece supported properly against the angle plate on marking off table to an accuracy of <math>\pm 0.5</math> mm.</p> <p>Marking location of the centers of circle by drawing horizontal &amp; vertical line &amp; then scribing circles using dividers. Use of Dot &amp; Centre punch for punching the lines, centers &amp; circles.</p> <p>Layout the dimensional features of the work piece using vernier height gauge, engineering Square, angle plate &amp; surface plate.</p>	<p>Measurement with precision instrument : Vernier calipers- principle &amp; construction, reading a vernier caliper, care &amp; maintenance etc.</p> <p>Vernier Bevel Protractor. Least Count of Various Instruments.</p>	<p>ISI. Types of Lines and application.</p>	
04	<p>Balancing of file using rough file to be continued on channel. Filing flanges of a channel for practicing of filing. Filing flat surface &amp;</p>	<p>Work bench, bench vice-constructural details, different types of vices, their uses, care and maintenance of vices.</p> <p>Files:- File parts &amp; material classification of files based on grade, cut, shape, length etc.</p>	<p>Free hand sketching practice of inclined lines and polygons, rectangles, squares etc.</p>	<p>Mensuration-Two dimension and three dimension</p>

	flanges of a channel maintaining parallelism between them using outside calipers within $\pm 0.5\text{mm}$	Printing of file, Convexity of file-reasons, reconditioning of files, file care & its uses. Methods for steady & accurate filing-no. of strokes per minute, right method of fixing file handle, care & maintenance of files.	Free hand sketching of measuring instruments like vernier calipers & micrometers.	
05	<p>Exercise on filing the adjoining outside faces of flanges of channel square to flat surface of channel as reference surface.</p> <p>Filing faces of channel for maintaining</p> <p>a. Flatness &amp; squareness of adjacent faces using tri-square.</p> <p>b. Parallelism between opposite sides. Filing with second cut file to prepare smooth surface.</p> <p>Exercises for filing practice to develop control on hand and feel for maintaining dimensions within <math>\pm 0.1\text{ mm}</math> using Vernier Caliper.</p> <p>Filing with second cut files to prepare smooth surfaces.</p>	<p>Introduction to layout marking, making media &amp; marking tools-construction, use, care and maintenance.</p> <p>Procedure of marking. Types of marking operations. Equipment and instruments:- Construction, use, care &amp; maintenance of surface plate, marking table, scribe, dividers, surface gauges, angular plate, marking block, V block &amp; clamp. Hermaphrodite caliper. Engineering square, parallel block, "C" clamp, tool makers clamp, combination set, bevel square etc. Introduction to punches, material, uses and care of various types of punches such as center punch, dot punch etc.</p> <p>Letter &amp; number punch set. Pin &amp; Hollow punches. Hammer parts, types, specification &amp; uses of hammers. Fitting the handle to the hammer head, precautions/care &amp; maintenance.</p> <p>Types of hacksaw frame special frames. Different parts. Types of Hacksaw blades, material specification &amp; uses. Reasons for breaking of hacksaw blades. Care &amp; maintenance, points to be observed while hack sawing to avoid breaking of blades. Safety to be observed while hack sawing.</p>		
06	Marking of profiles-combination of straight lines, circles, arcs & angles. Use	Types of Chisels-material, specification & application. Hot Chisels & Cold Chisels. Different cutting angles & their importance.	Orthographic Projection, Directional Views	Friction – Static & dynamic friction, Laws of friction.

	<p>of scale, divider, vernier height gauge, protractor, combination set etc. for marking profiles. Marking on the job piece for saw cuts. Gripping the job suitably in the vice jaws for hack sawing to dimension.</p> <p>Hack sawing various metallic pieces (Mild Steel, Aluminium, Copper, Brass, Stainless Steel etc.) of different thickness and cross sections (round, square, angles, flats etc.) using hacksaw blades of different TPI's within dimensional accuracy of + or – 0.5 mm.</p> <p>Hack sawing different lengths with hacksaw frame in horizontal &amp; vertical positions. Sawing along the parallel marked lines within 0.5 mm allowance for filing.</p> <p>Hack sawing steps and slots. Finishing hack saw cut pieces by filing for step &amp; slot fitting. Cutting of sheet metal with chisel.</p>	<p>Method of Chipping &amp; safety precautions to be observed while Chipping. Use of proper Hammer. Grinding-Sharpener of Chisel on bench grinding machine.</p>	<p>by Orthographic Projection method.</p>	
07	<p>Hammering practice on vertically held round job. Blind hammering practice. Stamping Letters &amp; Numbers on M.S. plates. Exercise on stamping to develop judgment, control on hand &amp; feel. Stamping practice on flat &amp; round material surfaces. Use of cross Peen</p>	<p>Types of Drills - Flat &amp; Twist Drills, straight fluted &amp; special types of drills, parallel &amp; taper shank drills construction/material &amp; use. Nomenclature of flat &amp; twist Drill-specification of Drill. Drill angles &amp; their importance, advantages &amp; disadvantages of flat &amp; Twist Drills. Drill Grinding-sharpening of Drills, Web thinning – checking</p>	<p>First angle method of projection</p>	<p>Problems on the above</p>



	Hammer for stretching of metal strip. Use of flat, cross cut & Round Nose chisels for chipping of edges & cutting grooves. Using cross cut chisel for cutting key way on round bar.	and round drill, common faults- mistakes & their ill-effects. Cutting speed & feed-setting/selection for various operations. Counter boring, pot facing & counter sinking operations of Drilling machine. Cutting fields (Coolants) used in drilling.		
08	Introduction to Drills. Preparations for drilling. Marking out the position of holes & Dot punching. Deepening the points with center punch. Checking for center distance. Drilling practice on sensitive drilling machine using different types of drills & drill holding devices. Safety to be observed while working on drilling machine. Marking, Chain drilling & filing to produce square, round & triangular openings on 6 mm thick plate. Preparing inserts by hack sawing & filing. Fitting inserts in the respective openings- exercise on step & angular fitting.	Introduction to drilling machine –Portable & Hand Drilling Machine. Bench and Pillar-Upright type drilling machine. Study of drill holding devices. Drill chuck, chuck key, drill drift, sockets & sleeves- construction, material & use. Method of drives, sizes, capacity & specification of a drilling machine. Special features, care & maintenance of drilling machine. Safety precautions to be observed while working on a drilling machine. Speed changing system, use of simple gear boxes, feed for drilling. Standard speed & feed for various material, various methods for job holding on drilling machine table. Drilling defects & their causes.	Third Angle method of projection.	Definition of cutting time, cutting speed, feed and depth of cut for drilling machine, lathe, shaping machine and planner.
09	Drilling practice on varying thickness & different materials such as Mild Steel, cast Iron, Stainless Steel, Copper, Brass, Nylon. Epoxy etc. Epoxy etc. Drilling on sheet metal. Precautions & safety to be observed. Counter sinking, counter boring & spot facing Operations using bench drilling	Introduction to reamers, types of reamers, pitch of flute, precautions to be observed while reaming. Allowances for reaming, coolant used while reaming. Floating holders for reamers. Construction & use of Hand Reamers, expansion reamers, adjustable reamers, taper reamers, rose reamers, chucking reamers etc. Elements & forms of screw threads. Single and multi-start threads, right & left hand	Compares on of first angle and third angle	Difference between counter sinking, counter boring and spot facing, thread cutting calculation.

	<p>machine. Exercises on Reaming with hand reamers &amp; machine reamers.</p> <p>Internal threading by hand using Tap Sets. External threading by split die &amp; finishing of thread by Die nut. Marking centers on two and end faces of a round bar with the help of "V" block &amp; clamp. Drilling &amp; Reaming of blind holes along the axis of round jobs.</p> <p>Grinding of drills &amp; chisels to specifications &amp; checking of angles with gauges.</p>	<p>threads. Hand and machine taps, sizes, tapping on different types of materials, Lubricants for tapping- tapping blind holes. Reasons for breakage of taps &amp; removal of broken taps. Tap Wrenches, construction, standard dimensions. Determination of sizes of drill for tapping standard holes. Cutting internal threads, tapping blind holes.</p> <p>Types of dies, solid and split dies, die stocks &amp; handles. Methods of thread cutting with die &amp; die stock. Setting the threading die. Use of lubricants. Use of hand chasers &amp; machine chasers.</p>		
10	<p>Exercise on filing - Radius &amp; .Angular filing using templates &amp; gauges.</p> <p>Filing Templates &amp; gauges for checking. Lathe tool angles. Filing to an accuracy of + or - 0.1mm., checking with Vernier Caliper.</p> <p>Preparation of plates for gauge fitting.</p> <p>Filing of various angles &amp; clearances of lathe tools on square blanks. Checking with templates &amp; Gauges already prepared.</p> <p>Measurement of shaft &amp; hole diameters using outside &amp; inside micrometer.</p> <p>Filing round on square bar within + or -0.1mm</p>	<p>Elements of interchangeable system. Definition of Limit, Tolerance &amp; Allowance Basic dimensions or sizes. How Limit &amp; Tolerance is denoted? Application of tolerance. Tolerance of Form &amp; Position. Use of symbols. System of Tolerance &amp; Limits, IS1 System. BIS System Terminologies used in practice and their definitions such as size, nominal size, basic size, actual size, limit of size, deviations (upper, lower., fundamental), zero line, tolerances, tolerance zone etc. Examples of fixing limits for various types of Fits commonly met with machine in relation with clearance &amp; interference.</p> <p>Component assembly such as, Free Fit Med. Fit, Snug fit, Wringing fit, Tight fit, Medium force fit, Shrinkage fit etc.</p> <p>Interchangeability &amp; standardization, method of selective assembly, hole &amp; shaft basis of</p>	Practice on First Angle and Third Angle, method of projection with only vertical and horizontal surfaces (5 sheets,)	Center Gravity & centroids of various fig tires and bodies

		system. Micrometer- inside & outside – constructional features, Principle operation, graduations, reading – use, care & maintenance. Purpose, types, construction, function and method to use comparators.		
11	<p>Use of Combination &amp; Round Nose Pliers to make different shapes/profiles by bending wire to match the blue print to develop manipulative skills, hand control &amp; eye judgment Using hand tools such as screw driver, single end/double end spanners, single end/double end ring spanners, box nut spanners, ratchet spanners, circlip pliers, wrenches, pullers, extractors, drift. Correct method to be used &amp; care to be taken in using these tools.</p> <p>Cold riveting. Marking out location &amp; drilling of holes for riveting. Use of dolly &amp; snap for forming rivet heads. Lap &amp; Butt Joint by cold riveting.</p>	<p>Types of spanners-their material &amp; uses- Box, Socket, Tubular, hook spanner etc.</p> <p>Wrenches – material &amp; use of T Socket, Monkey, Ratchet, Pipe wrenches etc.</p> <p>Types of screw drivers- materials &amp; uses.</p> <p>Types of Pliers- Material &amp; uses, combination pliers, Long nose pliers, flat nose pliers circlip pliers etc. Fasteners &amp; classification of fasteners. Permanent; Semi-permanent and temporary fastening devices, locking devices.</p> <p>Thread fasteners.</p> <p>Nut: Types of nuts- hexagonal nut, square nut, lock nut, check nut, castle nut, flanged nut, cap nut dome nut, slotted nut, serrated nut etc. and their functions.</p> <p>Bolts: Types –hex head, square head, round head, cheese head bolts, eye bolt, stud bolt. Screws: Set screw, machine screw, Philip head screw, sheet metal screw, wood screw etc. and their functions.</p> <p>Washers: locking plates, spring washers, fiber washer, tab washer, rivets, studs, pins, keys etc.</p> <p>Merits &amp; demerits with examples, advantages and disadvantages of using each one- where generally used and why?</p> <p>Keys &amp; cotters – Classification &amp; comparison of keys &amp; cotters.</p>	Various types of threads & rivets.	From the given drawing finding out the stretched length of jobs, internal dia, calculation of seamless pipes

		<p>Rivet and riveting – the object of riveting, the relation between the sizes of rivets and thickness of the sheets. Pitch of rivets.</p> <p>Rivet types, uses, method of riveting using snap and dolly.</p> <p>Riveted joints – likely mistakes while riveting and remedies.</p>		
12	<p><u>Project work:</u> making parallel clamp “C” clamp or micro meter stand by using acquired skills.</p>	<p>Scraping- importance of scraping- advantages – different methods of scraping- scraping procedure for producing flat surfaces. Checking of scraped surfaces- use of spirit level.</p> <p>Tools required for scraping.</p> <p>Scrapers- different types &amp; their correct use/application- use of surface plate, straight edge, angle plate, master cylinder in the process of scraping.</p>	<p>Free hand sketch of scrapper, spirit level, angle plate, st. edge</p>	<p>Stress, strain Hook’s law, elastic limit, ultimate stress, modulus of rigidity, Poisson’s ratio, temperature stress, resilience etc.</p>
13	<p>Scraping on flat surface. Taking impression for high spots using Persian blue. Sharpening of scrapers using diamond wheel &amp; lapping stone.</p>	<p>Properties &amp; uses of Ferrous and Non-ferrous metals and their alloys such as Cast Iron, Wrought Iron, Mild Steel, Carbon Steel, Tool Steel, High speed steel. Aluminium, Copper, Tin, Lead, Zinc, Brass, Bronze, White metal, Rubber and Plastic.</p> <p>Methods of producing Cast Iron Steel.</p> <p>Study of physical, chemical and mechanical properties of materials and testing of materials.</p> <p>Plastic deformation of materials - Cold &amp; Hot Bending- Bending- Bending of Strips. Change in mechanical properties of material in Hot &amp; Cold Bending. Meaning of tenacity, elasticity, malleability, ductility, toughness etc. With special reference to practical application -use of various engineering materials.</p>	<p>-do-</p>	<p>Practices to be considered selection materials strength rigidity, resistance fatigue, damping capacity, corrosion resistance etc.</p>

14	Filing & fitting practice within + or 0.06 mm thick plates. Dovetail fitting, hexagonal fitting, fitting of 40 mm size cube & 40 mm size square hole on 10 mm thick plate within tolerance of + or -0.04 mm. Six way fitting. Fitting exercise with reversible fitting.	-do-	Practice on single slant surface and double slant surfaces as per orthographic projection method.	-do-
15	Application and use of dial indicators, slip gauges and height gauge/height master. Application of various measuring instruments to measure of a component.	Study of slip gauges height gauges	-do-	Problems on slip gauges
16 & 17	<b><u>Application of Advanced Bench Working Skills</u></b> Practice on exercises involving making of simple machine parts which have certain functional relationship to other parts such as cam motion driving mechanism, dovetail by assembling parts using bolts, dowel pins, locking devices etc. Precision fitting jobs involving sliding, scraping & alignment.	Familiarization with plastic deformation of material, Cold & Hot bending of strips. Commonly used pipe-sizes, material and specification. Use of pipe for Hydraulics/Pneumatics & Lubricating system (Ferrous and non-ferrous) Bending of solid sections by using bending fixtures, bending dies etc. Cold and hot bending of pipes of different diameters of ferrous metal i.e. hydraulic pipes & Non-ferrous metal i.e. copper tubes for lubrication system. Pipe bending with or without filing in fine sand. Use of pipe bending fixture to maintain uniform bending radius. Precaution to avoid wrinkles. Pipe cutting using pipe cutter. Pipe threading & piping using various pipe fitting such as "T" fitting, elbow fitting, reducers etc. Punching of holes on leather with hollow punches. Preparation of gaskets & other packing	Elasticity, Ductility, malleability, Plasticity, Brittleness, Toughness, Hardness, Creeping, Creep stress, Fatigue stress, Impact stress etc. of metal	Free hand sketch of various types of CAMS-dovetail joints

		<p>materials. Standard pipe threads, cutting of pipe threads using Dies &amp; taps.  Care and precautions to be observed while using pipe vice, pipe wrenches, dies and taps.  Standard pipe fittings- Methods of fitting &amp; replacing the fittings.  Methods of protecting leaks all the joints.  House Hold piping- standard pipe fittings.  Fullering practice &amp; ferrule fitting.</p>		
18	<p>Filing flats on cylindrical parts. Filing square at the end &amp; in the middle of cylindrical rod within + or -0.04 mm.  introduction to lapping process. Laps &amp; lapping pastes, procedure for charging lap. Use of kerosene in lapping. Lapping on flat &amp; cylindrical (internal and external) surfaces.</p>	<p>Micro-meters- special types- important features &amp; applications, e.g. Thread checking micrometer, flange Micrometer, Depth Micrometer etc Sine bar, slip gauges- its principle of working &amp; applications. Purpose and method to use similar &amp; slip gauges and rollers</p>	- Do -	- Do -
19 & 20	<p>Bending of solid sections by using bending fixtures, bending dies etc  Cold &amp; Hot bending of pipes of different diameters of ferrous metal i.e. hydraulic pipes  Non-ferrous metal i.e. copper tubes for lubrication system. Pipe bending with or without filing in fine sand.  Use of pipe bending fixture to maintain uniform bending radius.  Precaution to avoid wrinkles.  Pipe cutting using pipe cutter. Pipe threading &amp; piping using various pipe fitting such as "T" fitting, elbow fitting, reducers etc.</p>	<p>Types of gauges- Plug , Ring, Snap, Taper, feeler, screw Pitch, Radius &amp; sheet metal gauges.  Dial indicators- construction &amp; use. Various types.  Comparators - Electrical, Optical pneumatic construction &amp; working principles.  Definition of surface finish. Terms used to describe the surface finish.  Dimensional Tolerance of surface finish according to IS1.  Surface quality &amp; its symbolic representation.  Equipment used for testing/measuring surface quality. Units of surface finish. Surface finishing processes, lapping, honing,</p>	<p>Lettering practice vertical style as per ISI</p>	- Do -

	<p>Punching of holes on leather with hollow punches.</p> <p>Preparation of gaskets &amp; other packing materials. Standard pipe threads, cutting of pipe threads using Dies &amp; taps.</p> <p>Care and precautions to be observed while using pipe vice, pipe wrenches. dies and taps. Standard pipe fittings- Methods of fitting &amp; replacing the fittings. Methods of protecting leaks all the joints. House Hold piping- standard pipe fittings. Fullering practice &amp; ferrule fitting.</p>	<p>electroplating, metal spraying, galvanizing, pickling and Meltaliation.</p>		
21 & 22	<p>Using hand tools such as screw driver, single end/double end spanners, single end/double end ring spanners, ratchet spanners, circlip pliers, wrenches, pullers, extractors, drift. Correct method to be used &amp; care to be taken in using these tools. Marking out key ways of various shapes. Using cross cut chisel for cutting corners. Checking depth with depth gauge &amp; fitting key ways. Making different types of keys &amp; key ways on pulleys, gears etc. by hand.</p>	<p>Definition of lapping &amp; its necessity. Constructional features of lapping. Design of laps-Cast Iron, Copper, Lead, Mild steel etc. Abrasive material and the form in which it is applied. Popular names of abrasive used. Simple examples, practical situations of lapping. Lapping methods &amp; their applications. Testing of surface quality after lapping. The objective of honing-Honing-description of honing and its necessity – Honing methods and their use. Simple examples, situation where honing is used. Rotary &amp; Longitudinal motion in honing Cylindrical object. The effect of Honing on the efficiency of running components. Honing tools-shape of abrasive-Grades. Honing allowance</p>	<p>Free hand sketch of various types of keys</p>	<p>-do-</p>

23	Familiarization and use of different types of ropes such as hemp, manila, nylon, wire etc. Practicing different types of knots and its applications. Method of joining two ropes together for extension. Detection of unsafe/defective conditions of ropes and knots. Specifications and correct use of slings. Safety to be observed in the use of ropes and slings.	Specification and use of different types of ropes such as hemp, manila, nylon, wire etc. Practicing different types of knots and its applications. Method of joining two ropes together for extension. Detection of unsafe/defective conditions of ropes and knots. Specification and correct use of slings. Safety to be observed in the use of ropes and slings.	- Dimensioning technique and systems in dimensioning. General rules in dimensioning.	Various types of pulleys.
24	Basics and use of different types lifting tackles both mechanical and hydraulic such as – screw jacks, chain pulley block, crabs and winches, rollers and bars, levers, lashing and packing. Use of inclined plane, hydraulic trolleys etc. Care and maintenance of lifting equipment and safety to be observed by handling the equipment. Use of hoists and cranes for lifting purpose. Constructional features Methods lifting jobs of various shapes, sizes and weights. Use of appropriate length of chains. Inspection of chain links.	Different types of appliances and tackles for shifting, loading and unloading of machine and equipment. Screw jacks- their use and working principles. Chain pulley blocks- their use and working principles. Crane and Hoist for lifting purpose – working principles & main constructional features. Working principles & use of other tackles like Crabs, winches, slings, rollers and bars, levers, lashings and packing. Mechanical advantage and velocity ratio. Use of inclined planes. Special precautions in handling heavy equipment, removal and replacement of heavy parts. Safety in transportation.	Development of surfaces -	Definition and problems of various types of simple machines
25.	Project Work / Industrial Visit (Optional)			
26.	Examination			



**Syllabus for the Trade of “MECHANIC MECHATRONICS”**  
**Under Craftsman Training Scheme**

**(Semester Code no. MMC - 02)**

**Duration : Six Month**

**MECHANIC MECHATRONICS Semester-II ( Production Technology and Fabrication)**

Week No.	Trade Practical	Trade Theory	Engineering Drawing	Workshop Science & Calculation
1 to 4	<p><b>Machine tool technology</b>            Constructional features and working principles of Lathe machine.            Functional relationship of various parts of the machine.            Study of the gear box and drives used on the machine.            Study the methods of holding work piece and tool using different devices.            Exercises on plain, stepped, taper and form turning, knurling etc.            Exercises on drilling, reaming, boring counter boring etc.            Screw thread cutting both e            Exercises on eccentric turning.            Grinding of Lathe tools.            Care and maintenance of machines.            Safety precautions to be observed while handling machines.            Study of lubrication system</p>	<p><b><u>Introduction to metal cutting process</u></b></p> <p>Metal cutting and cutting tools.            Mechanism of metal cutting- orthogonal and oblique cutting, chip formation, types of chips and chip breakers.            Cutting tool geometry and nomenclature, control of angles, tool life.            Cutting speed and feed and its calculation.            Properties and uses- cooling system types – soluble oils-soaps, paraffin, soda water etc. bio- degradable oil.            Effective of cutting fluids in metal cutting.</p>	<p>Introduction to sections and sectional views.            Different types of sections used in engineering drawing.            Conversions used in engineering drawing.            Different sectional view, exercises (@ 5 to 6 sheets).-</p>	<p>Ferrous materials-pure iron, cast iron, wrought iron &amp; steel- manufacturing Process, composition and uses.            Heat treatment of iron and steel.</p>

	<p>and preventive maintenance. Simple projects such as hollow punch, pulleys, gear blanks, simple couplings etc.</p>	<p><b>Introduction to Turning machine</b> Constructional features, types, functions and use of Lathe machine. Study of Lathe accessories – face plate, chucks, steadies their use. Driving mechanism – Gear box mechanism-gearing, common lathe operations- chucking, centering, plain turning, facing and boring, taper calculations – screw cutting. Cutting speed and feed, use of coolants. Care and maintenance-preventive maintenance.</p>		
5	<p>Constructional features and working principles of shaping machine. Functional relationship of various parts of the machine. Study of Quick Return Mechanism. Different work and tool holding devices. Flat and angular shaping. Groove cutting on shaping.</p>	<p>Constructional features, function and use of shaping machine, working principle, use of Quick Return Mechanism. Setting of length and position of stroke. Holding of work piece &amp; tools. Various cutting tools and tool angles for carrying out shaping operations. Speeds and Feeds. Use of coolant for different materials. Detection of common faults &amp; their rectification.</p>	Free hand sketch of single and multipoint cutting tools.	Ratio and proportion

6 to 8	<p>Practice on Milling Machines Constructional features and working principles of Milling Machine. Functional relationship of various parts of the machines. Study of gear box and drive used on the machine. Study of different work and tool holding devices. Exercises on parallel and angular milling. Exercises on grooving using end mills. Cutting of gears-spur and helical using simple indexing. Use of slotting attachment for cutting keyways. Care and maintenance of machine. Safety precautions in handling machine. Study of lubrication system and preventive maintenance. Simple project such as jaw, claw, Oldham coupling, spline cutting etc.</p>	<p>Introduction to Milling Machines Constructional features and working principles, types, functions, use of milling machines, attachment and accessories. Different methods of holding work piece and cutters. Common milling operations such as plain, step, angular milling, slot and groove cutting, use of dividing head for indexing-types. Various types of gears and elements gears. Gear cutting and Cam cutting. Various speed and feed. Use of coolant for different materials. Detection of common faults-detects and their rectification. Safety precautions. Care and maintenance-preventive maintenance of milling machines.</p>	Introduction to autocad.	Cutting fluids- lubricants and coolants
9 &10	<p>Practice on Grinding Machine Constructional features and working principles of surface and cylindrical grinding machines. Functional relationship of various parts of the machine. Study of drive-both mechanical</p>	<p>Introduction to Grinding Machines Constructional features, types, functions and use of grinding machines. Grinding wheels and their specifications-grit,</p>	--do--	Dynamics –Speed and velocity, acceleration, difference between speed and velocity. problems in the above.

	<p>and hydraulic. Study of different work holding devices. Grinding wheel specifications. Mounting, balancing, turning and dressing of grinding wheels.</p> <p>Exercises on surface grinding-parallel and angular, step and groove grinding.</p> <p>Exercises on external and internal cylindrical grinding-both plain and taper.</p> <p>Study of hydraulic systems used on the machine.</p> <p>Care and maintenance of machine. Safety precautions to be observed while using machine. Study of lubricating system and preventive maintenance.</p> <p>Practice in drawing simple geometric shapes on sheet metal using marking tools.</p>	<p>grain size, structure, bond, grades etc.</p> <p>Use of grinding wheels, balancing and truing. Dressing of grinding wheels, holding of work piece.</p> <p>Various grinding operations-external, internal, surface grinding.</p> <p>Common defects-faults their detection and rectification.</p> <p>Use of coolants for grinding different materials. Safety precautions to be observed in grinding operations.</p> <p>Care and maintenance-preventive maintenance of grinding machines.</p>		
11	<p>Practice in drawing simple geometric shapes on sheet metal using marking tools.</p> <p>Practice in cutting sheet metal in these shapes and cutting sheets to various angles using hand shear, snip and chisel.</p> <p>Bending sheet metal to 90° using wooden mallet, clamp etc. on a bench vice.</p> <p>Practice on lap joint, lock grooved joints and hammering.</p> <p>Cutting practice with different snips, cutting of notches, inside</p>	<p>Material Science &amp; Process</p> <p>Commonly used sheet metals-rolled sheets such as tin, galvanized iron, copper, brass, aluminium sheets-their physical properties and uses.</p> <p>Common tools used for sheet metal-Tina man, mallets, stakes, swages, shears, snips, stripes, scribers, trammels, dividers etc.</p> <p>Simple developments and</p>	Missing views and practice on above portion. (sectional view exercise).	

	<p>and outside curves.  Sheet metal cutting on shearing machine.  Safety in operations.  Forming rectangular, round and conical shapes using stakes.  Removal of dents and simple hollowing practice.  Use of hard and soft solder.  Soldering practice on ferrous and non-ferrous metals.  Practice in riveting sheet metals of various thicknesses.  Exercise using pop rivets. Simple development work. Practice in marking simple articles such as, machine guards, shovels and trays, funnels, taper bins etc.</p>	<p>method of laying out  Types of joints-folded joint, grooved and beads etc.  Soldering, sweating, brazing and tinning-materials and method employed.  Soft and hard solder-their composition, properties and use.  Fluxes and spelters-importance and use.  Soldering iron-types and uses.  Preparing the job for soldering, method of soldering.</p>		
12 & 13	<p>Practice &amp; Application of Meterological Instrument &amp; Inspection techniques  Application and use of dial indicators, slip gauges, height master and various measuring instruments (such as inside caliper, dial bore gauges, three leg micrometer, dial micrometer and comparator) to measure internal and external features of the component.  Measurement of co-ordinates, center distance, angle, centricity, eccentricity, dovetail slot etc. by using :-  i) Lever type dial indicator and slip gauge.  ii) Lever type indicator</p>	<p>Introduction Meterology &amp; Inspection Techniques:  Inspection, quality control, quality assurance, total quality management concepts and quality awareness.  Zero defect, self inspection and applications.  Statistical process control:-  a) control charts  b) chance causes and assignable causes  c) plotting of control chart  d) Various type of trends.</p>	Orthographic views in I angle principle	Simple Problems in analytical geometry involving distance and coordinate axes.

	<p>and height master.</p> <p>iii) Dial indicator and rollers and pins.</p> <p>iv) Turning the job with the help of screw jacks (for casting, forging etc.)</p> <p>Practical exercise for thorough understanding of statistical processes control concept.</p> <p>Construction and use of various control charts. Detection of chance and assignable causes and study of various trends.</p>			
14 to 17	<p>Practice on welding Process</p> <p>Working principles of Arc, gas and spot welding machines. Connecting and setting of machine for operation.</p> <p>Safety to be observed in welding work. Practice in simple arc welding using materials of different thickness. Horizontal and vertical position welding.</p> <p>Practice on butt and lap joints.</p> <p>Practice in brazing of ferrous and non-ferrous metals, silver brazing, braze welding (dissimilar metals).</p> <p>Study of welding defects (arc and gas) and precaution to avoid them.</p> <p>Practice in metal deposition for joining of cranks, repairing of worm out parts, key ways, keys, broken gears, teeth, filling and padding on shafts. Practice in flame cutting. Care and</p>	<p>Introduction to Welding :</p> <p>Gas and electric welding – tools and equipment.</p> <p>Principle of fusion welding. Types of joints and method of welding.</p> <p>Safety precaution and maintenance of equipment.</p> <p>Welding defects – causes and how to avoid them. Flame cutting – principle and use of equipment.</p>	Welding symbols & sketch of welded joints	Classification of steel and its alloys.

	<p>maintenance of welding equipment.</p> <p>Safety precautions applicable to electrical trade. Grinding of wire as per ISI and cables, colour coding used on them.</p> <p>Removal of insulation of wires/cables and soldering free ends of copper strands.</p>			
18 to 21	<p>Joining of flexible cables by soldering. Staggered joints in case of twin wires or multi-core cables. Familiarization with different types of plugs, sockets, switches, fuses and fuse holders, cut outs etc. with their specifications and applications. Testing of switches, buttons, limit switches, micro switches by using continuity tester for their operation. Identification of live, neutral and earthing wires before connecting cable to plugs, sockets, switches, cut outs etc. Use of test lamp and multi-meter for identifying single phase/three phase power supply. Use of multi-meter for voltage, current and resistance measurement. Checking of DC supply. Use of voltmeter and ammeter for voltage and current measurement respectively. Connecting portable single phase AC operated industrial equipment such as drilling machine and domestic applications such as washing</p>	<p>Introduction to general Electrical &amp; Electronics</p> <p>Modern theory of atomic structure in general – nucleus, orbits and free electron, orbital electron, valance electron – free electron. Classification of materials as conductors and insulators, semiconductors and resistors. Concept of electromotive force, voltage current and Resistance. Electrical safety rules and precautions. Ohm’s Law and Kirchoffs voltage and current law. Types of circuits – series, parallel and series – parallel. Electrical work, power and energy – definitions and units of measurement and their inter relationship. Primary sources of electromotive force</p>	<p>Colour code of cables, cable joints (Straight &amp; ‘T’ joints)</p> <p>Series parallel circuits</p> <p>Basic Logic gate circuits &amp; flip-flops</p> <p>Fluorescent lamp circuit, battery, series parallel connection.</p> <p>Wiring diagrams of fluorescent lamp fitting.</p>	<p>Units of Electrical definitions &amp; unit conversion .</p> <p>Problems solving using ohms law&amp; kirchoffs law, faradays laws, electromagnetic induction, power, time, energy.</p>

	<p>machines, cooking range, geyser etc. Practice of series and parallel connection of loads and measurement of voltage drops across the loads and line current. Practice of logic development for control. Constructing logic gate circuits such as AND, OR, NOR etc. by using series and parallel combinations of switches to control the condition of load lamp(ON or OFF) – condition of out put lamp indicating out put conditions in truth table. Wiring of simple electrical circuits (to understand the concept of control) on test boards such as single point, series parallel, master, staircase, godown, control of lamps. Wiring and testing of fluorescent lamp fitting. Function of chock and starter in its operation. Care and maintenance of batteries – charging of batteries. Series and parallel connection of batteries.</p>	<p>/electrical energy. Primary and Secondary cells. Introduction to electrical supply system with special reference to AC. Different voltages in use AC and DC. Types main switches, circuits breaks, fuses etc. effects of electric current in general.</p>		
22 to 24	<p>Practical on basic Electronics Scope of industrial electronics with reference to its applications in machine tool operation. Identification of basic components such as registers, capacitor, inductors etc. from their outlook. Types, specifications and general applications of these components. Testing and</p>	<p>Basic Electronics Semi-conductor theory. Intrinsic and extrinsic semi-conductors. P and N type semiconductors and P-N junction – semiconductor diode – two layer and two terminal device. Use of PN junction as</p>	<p>Symbols of R,L,C diode,etc,</p>	<p>AC circuit- elements of AC circuits, single and three phase supply wire, cables, fuse, C.B., relays, S.W., band, panel board, transformers. Series, parallel, combination of resistors, Capacitors and inductors.</p>



	<p>measurement of their values using multi-meter. Use of resistance colour codes. Soldering and desoldering of component on and from printed circuit boards (PCB). Precautions to be taken while soldering on PCB. Study of rectifiers circuits – half wave, full wave and bridge rectifiers. Use of oscilloscope for checking of input and output wave forms. Study of solid state devices such as diodes, transistors, SCRs and ICs available in different packages. Types and applications. Identification of leads and testing by multi-meters. Assembly of simple battery eliminator circuit using bridge rectifier and filter capacitor. Measurement of input and output voltages. Familiarization with soldering station, Soldering station, Desoldering station, IC tester</p>	<p>switch. Use of PN junction for rectification. Half wave, full wave and bridge rectifiers. P-N-P and N-P-N junction devices –transistor – three layer three terminal devices. Use of transistor of a switch and its simple applications. Use of transistor for amplification – how amplification takes place. Soldering technique as applied to PCB soldering DO's and Don'ts. Introduction to SMD</p>		
25	Project Work / Industrial Visit (Optional)			
26	Examination			

## Syllabus for the Trade of “MECHANIC MECHATRONICS”

### Under Craftsman Training Scheme

(Semester Code no. MMC - 03)

Duration : Six Month

#### **Semester-III (Basic Mechanical & Electrical Maintenance including Hydraulics & Pneumatics)**

Week No.	Trade Practical	Trade Theory	Engineering Drawing	Workshop Science & Calculation
1	Industrial hydraulics – principles, advantages, disadvantages and safety. Study of block diagram of hydraulic system in general. Construction features, principles of operation, function and uses of various hydraulic components such as pumps, valves, actuators and power pack. Hydraulics fluids – specifications, properties and applications. Study of hydraulic power pack and its control elements. Familiarization with various symbols used in hydraulic circuit diagram. Identification of components and their specifications. Hydraulic circuit reading and tracing practice. Constructing simple hydraulic circuit for linear /rotary / motions and testing for operation. Constructing simple hydraulic circuit for speed control both linear and rotational and testing for operation and troubleshooting.	Industrial hydraulics – principles, advantages, disadvantages and safety. Study of block diagram of hydraulic system in general. Construction features, principles of operation, function and uses of various hydraulic components such as pumps, valves, actuators and power pack. Hydraulics fluids – specifications, properties and applications. Study of hydraulic power pack and its control elements. Familiarization with various symbols used in hydraulic circuit diagram. Identification of components and their specifications. Hydraulic circuit reading and tracing practice. Circuit drawing practice using symbols. Constructing simple hydraulic circuit for linear /rotary /motions and testing for operation. Constructing simple hydraulic circuit for speed control both linear and rotational and testing for operation and troubleshooting.	Drawing of Hydraulic & Pneumatic symbols. Block diagram of hydraulic & pneumatic power pack.	Pascal’s law for pressure, force & velocity. Effect of viscosity with respect to temperature.

2	<p>Construction features, principles of operations and uses of pneumatic components such as valves and their actuators. Identification of components from their outlook and their specifications. Pneumatic circuit reading (from manuals) and circuit tracing practice. Circuit drawing practice using symbols for simple application. Constructing simple pneumatics circuits for linear reciprocating and rotary motion. Testing for operation and troubleshooting.</p>	<p>Construction features, principles of operations and uses of pneumatic components such as valves and their actuators. Identification of components from their outlook and their specifications. Pneumatic circuit reading (from manuals) and circuit tracing practice. Circuit drawing practice using symbols for simple application. Constructing simple pneumatics circuits for linear reciprocating and rotary motion. Testing for operation and troubleshooting.</p>	<p>Geometrical constructions polygons in circles</p>	<p>Definition of linear and angular velocity</p>
3 to 5	<p>Introduction to leveling of machines. Practice on leveling – use of spirit level, camel back, straight edge, bridge, parallel blocks etc. Leveling of surface plates, marking table, milling machine, grinding machine etc.– precaution of test report indicating degree of flatness. Use of leveling bolts, taper wedges for levelling of horizontal and vertical surfaces. Introduction to machine alignment. Checking lathe, milling, grinding machines for alignment and preparing test reports comparing with standard test charts.</p>	<p>Methods employed for installation and erection of precision and heavy duty machines. Location and excavation of foundation. Different types of foundations – structural, reinforced, wooden, isolated foundations. Foundation for heavy machines such as presses / hammers etc. Foundation for precision machines – special precautions necessary for erecting precision machines. Importance of isolated foundation. Special process involving in erection of heavy duty machines. Layout of machines – consideration of power, space, weight, ventilation and moving parts etc. Types of vibrators, causes and prevention of vibrations. Methods of insulation of machines of machines</p>	<p>Geometrical constructions on inscribed circles in polygons. Geometrical constructions on described circles in polygons. Geometrical constructions on tangential arcs and circles.</p>	<p>Definition of taper and its calculation. Definition of mass, weight and their relationship</p>

		<p>against vibration. Anti-vibration devices and their locations.</p> <p>Different types of instruments used for checking the vibrations.</p> <p>Leveling machines, importance of leveling. Methods of grouting.</p> <p>Use of machine levelling screws.</p> <p>Methods of leveling, precautions to be taken while leveling, levelling accuracy – its measurement.</p> <p>Special precautions necessary for precision machines. Use of spirit level, its construction and use. Use of camel back, straight edges and slip gauges for leveling.</p>		
6 & 7	<p>Study of various spindle drive mechanism used on bench grinder, drilling, milling, lathe and grinding machines. Checking for spindle run-out – axial and radial play. Setting of play as per standard chart. Checking of bearings for its performance – repairs and replacement as needed.</p> <p>Study of shafts, axels, couplings and clutches used on various machines. Locating and identifying these elements on various machines. Dismantling clutch mechanisms. Study of standard machine elements. Cleaning and inspection of parts for any damages/wear out etc. And carrying repairs of replacement. Assembly and oiling of clutches and fitting back to its location. Testing for operation. Preparation of reports.</p>	<p>Machine alignment – different types- procedure. Equipment for aligning machine – use of test mandrel, master cylinder, straight edge, centricities, slip gauges, dial indicators etc. Precautions to be observed in the use of equipment while aligning.</p> <p>Special precautions necessary for erection, levelling and aligning precision machines. Testing for correct functioning of machine parts, machine commissioning.</p>	<p>Preparation of templates by using tangential arc method. Engineering curves – parabola and hyperbola.</p>	

8	Study of Belt Pulley, Chain, Gear, Rack & Pinion etc. Used on different Machines. Introduction to various gear transmission mechanisms. Removing gear box from various machines and opening for inspection and study of gear trains and their functional relationship. Dismantling of gear box completely. Study of various machine elements from the gear box. Cleaning and checking / inspection of parts for damage / repairs. Assembly of gear box and fitting back to the machine. Testing and preparation of report.	Prime movers. Types of drives- Rope & Chain. Variable speed transmission PIV drives and Harmonic drives. Friction drives. Clutches- positive clutches friction clutches. Mechanical, Hydraulic and Pneumatic drives- basic principles and uses. Individual drive and group drive. Care and Maintenance of different types of drives and their applications. Study of individual drive system, reciprocating, reverse, eccentric, cams, cranks drives. Rotary to linear drives and vice-versa. Power transmission elements. Shafting shaft, types of shafts-rigid and flexible and hollow.	Ellipse 4 types of constructions @ 2 sheets.	Problems on transmission media (Belt, gear, & chain)
9	- Do -	Types of pulleys solid, split, "V" groove, step, cone, taper, guided and jockey or rider pulleys etc. their functions and uses. Specifications and selection of pulleys for specific applications. Necessary calculations for deciding to size diameter, width, weight etc. Consideration of drive to driven ratio. Crowning of pulleys. Fast and loose pulleys.	Exercise on sectional views.	- Do -
10	Inspection of machine guide ways and slides. Checking for straightness, flatness, scoring/scuffing marks and	The object of belts- Types / sizes / specifications and uses. Materials used for belts-leather, cotton,	Construction on involutes.	--do--

	<p>condition of oil grooves and wear. Adjustment of Gibs, wedges for setting the gap. Use of Feeler gauges and dial indicator. Study of feed Mechanism- Removing, dismantling, cleaning and oiling of its machine elements assembly and fitting back to its position. Testing for its operation.</p> <p>Mechanism to be studied-</p> <ul style="list-style-type: none"> <li>-Lathe machine-carriage, apron, feed box, head stock etc.</li> <li>-Milling machine Feed box (column, knee, saddle) rapid traverse gear box, intermediate gear box etc.</li> </ul>	<p>canvas, Indian rubber (Batala). Selection of the type of the belt with the consideration of load and tension. Leather belts-methods of joining the ends/bolting leather belt and their specific advantages. Belt Fasteners-different types, advantages &amp; disadvantages of each other.</p>		
11	<p>Familiarization with plain/journal bearings, anti-friction bearings used on machine assembly. Specification &amp; selection for appropriate use. Use Mounting of bearing on shafts and in housing with proper fit &amp; axis alignment. Use of proper tools. Removal of bearings from shafts &amp; housing by using pullers. Cleaning up &amp; removing old metal form bearing and replacing with new metal. Scrap &amp; fit bearings to a shaft. Fitting shaft to main line bearings. Cut oil grooves in bearings. Checking of shafts for alignment with dial indicator, practice in scraping flat bearing surfaces.</p>	<p>Types of belt drives, velocity ratio of belt drive. Horse Power transmitted by belt. Ratio &amp; driving tension in a belt. Parallel &amp; cross belt drive, open &amp; cross belt drive, angular belt drive. Geometrical explanation of the belt drives at an angle. Belt speed used for commercial belts. Calculation for the size of the new belt. Slipping of the belts-causes &amp; remedies. Use of guide pulleys, crowing, use of dressing and resin power to avoid creep and slipping. Use of chains, wire rope for power transmission. Methods of fixing and uses. Types brief description. Types rigid coupling-Flange coupling.</p>	<p>Construction of cycloidal curves-cycloid, epicycloids, hypo-cycloid and Archimedean spiral.</p>	<p>Problems on pulleys</p>

		<p>Hook's coupling, Universal coupling, Flexible couplings their different uses. Friction and Universal coupling advantages and disadvantages over each other &amp; their applications. Types and uses, their function and application. Pre-requisites of a key – prevention of circular/longitudinal motion of machine parts. Types of key and key ways, their uses and applications. Preparation of keys, allowable tolerance, clearances. Key fitting procedure-methods. Procedure for removing keys. Types &amp; uses of key pullers. Use of keys in power transmission.</p>		
12	<p>Study of Various machine tools such as Lathe, Milling Grinding &amp; shaping machine with special attention to transmission mechanism. Study of machine accessories, their function and operation. Study of lubrication systems and maintenance. Introduction to magnetic clamping devices such as magnetic chucks, lifting magnet - working principles, testing and safety aspects in handling/using such devices.</p>	<p>Types-materials and uses of gears. Various manufacturing processes. Study of spur gear elements-tooth profile-pitch circle-diametric pitch velocity ratio of a spur gear. Helical, Herring bone, Bevel, Spiral Bevel, Hypoid Gears. Rack and Pinion-Worm and Worm Wheel gearing, velocity ratio of Worm gearing. Repairs to gear teeth by binding up and dovetail insert method. Method of fixing geared wheels for various purpose drives. General causes of the wear &amp; tear of the</p>	--do--	<p>Problems on gear cutting &amp; shaping machines</p>

		toothed wheels & their remedies. Methods of fitting spiral gears, helical gears, bevel gears, worm and worm wheels in relation to required drives. Care and maintenance of gears.		
13	--do--	Method of reducing friction, Use of bearing advantages & disadvantages. Bearings-different types of high speed & low speed their application. Material for the bearings and their properties. Specification of bearings, dimensional relationship of the shaft with bearing-the type of loads. Method of clamping and fitting the bearing in the mounting and dismounting. Essentials of Ordinary type Brass bearing-process of fitting. High speed and loaded bearings-use of ball and roller bearings-constructural features of ball & roller bearings and housings. Method of Ball and Roller bearings on the shafts. Commercial specifications of Ball and Roller bearings. Anti-friction bearings-their types and uses. Lubrication of bearing high speed bearing. care and Maintenance and inspection of bearings.	Construction of Helix on cylinder and on cone.	Load calculation on bearings
14	Dismantling simple mechanisms such as machine vice, three jaw chucks, index head, tail stock, slotting	--do--	Exercise on Orthographic views, dimensioning and	Definition of moment of inertia & problems.



	attachment, coolant pumps, using various hand tools with specific reference to functional part of their machine elements. Cleaning of Oiling of dismantled parts, Assembly & Testing for operation.		sectioning.	
15	- Do -	Introduction to maintenance work. Importance of maintenance. Methods & tools of maintenance, basic concepts of routine & preventive maintenance. Importance of preventive maintenance. Inspection, diagnosing and repairing procedure. Scheduling and planning for preventive maintenance work. Maintenance of records, log cards etc. Function involved in preventive maintenance. Advantages of preventive maintenance. Frequency of preventive maintenance-preparing preventive maintenance schedule-points to be considered, lubrication survey system of symbols and colour coding.	--do--	Estimating & costing of job
16	Dismantling of simple machines such as Bench grinder, Pedestal Grinder, Sensitive Drilling machines. Cleaning & Oiling of parts & assembly & Testing	Methods of repairing damaged parts. Major overhauling. Reconditioning of machines methods of reconditioning measuring instruments used in reconditioning special tools, test mandrels, spooling gauges, bridges used in re-conditioning	--do--	--do--

		testing of machine after repair. Preparation of test chart.		
17	Use of painting/protective coating for rust prevention. Surface operation, use of primers and surfaces. Brush and spray painting- painting metallic and wooden articles. Lacquering practice.	Methods of various set ups. Reclamation of worn out parts such as slides, gears, shafts, broken parts of cast iron etc. by metal deposition hard chrome plating etc. Conservation of wear forms of wear. Introduction of special tools used in maintenance voltmeter, Tachometer, Spirit Level etc. Materials used for leak proof joints. Preparation of gaskets and their mounting procedures. Sealing and Packing elements. Detection of common faults & their rectification in general. Painting. Procedure to prepare surface, use of protective coating, brush & spray painting on metallic & wooden articles, precaution to be observed during brush & spray painting.	Projection of lines, planes and solids @3/4 sheets.	--do--
18 to24	Familiarization with electrical symbols being used in electrical circuit diagrams. Practice in reading electrical circuit/connection diagrams from the instructional manual. Circuit tracing practice. Identifying electrical hardware items from their out look. Checking/testing Contactors. Developing control circuit using ladder/schematic diagrams. Use of control elements to build	Planning for scheduled overhauling of machine. Methods of dismantling, precautions to be taken while dismantling. Sequence of operations by making on parts. Methods of cleaning of parts. Solvents and cleaning materials their names and specifications. Proper method of removal and fitting of bearings. Re-assembly of machines	Practice on Basic electrical symbols.  Wiring diagram of speed control of AC/DC Motors.  Connection diagram of megger Wiring diagram of speed	Cost of power consumption

<p>and test manual, inching, hold on and start/stop push button control circuits. Circuit building practice. Wiring of power and control circuit on test board such as direct on line starter, automatic star-delta starter and forward/reverse control for 3 dia. Induction motors etc. Study and use of safety elements such as miniature circuit breaker (MCB), over load relay, earth leakage relay, protecting fuses in power circuit wiring and testing. Measurement of winding and body resistance of DC motors and induction motors by Multimeter. Connecting induction motor to panel and measurement of line current. Simulated fault finding on control panel. Isolation of machines from electrical cabinet by removing back up fuses, switching off main switch. Replacement of brushes, setting of brushes. Locating over loaded motor and finding out its causes such as fuse blown, mechanical jamming, loose connections, faulty settings etc. Locating faults in power circuit such as power fuse blown, MCB tripped, control fuse blown etc. Checking of electrical motors by measuring winding resistance, balance of resistance, body resistance. Checking of electromagnetic clutches, brakes, chuck magnet etc.</p>	<p>in correct sequence and testing for correct functioning. Machine vice, three jaw chuck, index head, tail stock slotting attachments and coolant pumps using various hand tools with specific reference to functional parts for machines such as bench grinder, pedestal grinder, sensitive drilling machine etc. Advanced electrical electro-magnetism. Concept of a coil (Electromagnetic) and Capacitors-principles of operations. Use of a coil in hydraulic and Pneumatic solenoids. Use of capacitors to store energy. Electromagnetic induction, Motor effect and generator effect. Electrical motors- construction and features, types of both AC and DC motors and applications. Measurements of electrical quantities –Use of voltmeter, Ammeter and Multimeter-principles of operation. Elements of electrical system control power and safety elements. Circuit breakers, fuses, contractor, relays, timers-principles of operation &amp; constructional details. Simple motor control, inching control, star delta control starter, push button switches, limit switches. Micro switches, pressure switches over load relays etc. Safety interlocks, Speed control of AC induction &amp; DC motors.</p>	<p>control of AC/DC Motors.  Connection diagram of megger</p>	
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		Automatic operation-use of control circuits-logical development of control circuit diagram using contractors and relays. Concept of ladder diagram. Understanding of power and control circuit in general (with few examples). Inter related between them. Safety in handling and operating electrical equipments.		
25	Project Work / Industrial Visit (Optional)			
26	Examination			

## Syllabus for the Trade of “MECHANIC MECHATRONICS”

### Under Craftsman Training Scheme

**(Semester Code no. MMC - 04)**

**Duration : Six Month**

### **Semester-IV (CNC Machine Maintenance)**

Week No.	Trade Practical	Trade Theory	Engineering Drawing	Workshop Science & Calculation
01	Introduction to logic gates and their truth tables. Building logic gates such as AND, OR, NOR, INVERTER, NAND, EX-OR using diodes and transistors out put lamps indicating conditions in truth table (Analogy of logic gates to series and parallel combination of switches).	Introduction to logic gates e.g. AND, OR, INVERTER, NAND, NOR, EX-OR, etc. Their truth table analogy of logic gates, combination of series and parallel switches		
02 to 08	Study of commonly used Transducers- such as thermocouples, LDRS, thermistors, LVTs, strain gauges, magnetic pick up photo diodes, photo transistors etc. Familiarization with commonly used controls in our industry such as Timer, Counter, proximity switches (DC and AC), over current relays, DC motor controllers, photo electric relays, temperature controls. Demonstration of each controlling unit. Introduction to programmable logic controller (PLC-only concept). Its fundamental block such as input, output, memory, power supply etc. Comparison of PLC with conventional machine control (Appreciation only). Programme development terminal (PDT). Functions of keys on PDT.	Introduction to commonly used transducers in industries such as Timers of different types, counters, proximity switches (AC and DC), over current relays, DC motor controller, photo electric relays, temperature controller. Concept of programmable logic controllers-its fundamental blocks- input, output, memory, power supply, comparison of PLC with conventional terminal, function of various on PDT.	Block diagram by LVDT, Block diagram OCR, Block diagram TC. Basic Block Diagram of PLC Simplifying Diagram. Timer circuit, Thermocouple, Opto-Electronic Devices like photodiode, Photo Transistor	Brazing lubricants & coolants. Cutting speed and feed. Simple problems on calculation by Stress, Strain, Calculating the cost of repairing and record the timing Control PLC.

09 to 10	<p>Circuit building practice-regenerative (sequencing) circuit with speed and pressure (clamping) control. Counter balance circuits with speed control. Traverse and feed circuits. Differential check valve, pressure regulator valve, pressure relief valve etc. Study of stackable (modular) type hydraulic control valves. Study of manifolds, accumulator, intensifier, rotary joints etc. Study of machine tool applications of the hydraulic drives for rotary, reciprocating, speed changing, clamping, unclamping and feed motions. Trouble shooting in hydraulic drive circuits for low pressure, noisy system, reduced speed of the table traverse, jerky traverse of machine table, jamming of piston rod at the end of the stroke, pressure increase in the system etc. Repairs and maintenance of the pumps-gear, vane and radial position. Repairs and maintenance of valves-pressure control, direction control and flow control. Adjustment of valves. Repairs and maintenance of actuators-single and double acting cylinders, hydraulic motors etc. Piping practice with metallic and hose pipes. Use of various types of pie joints and fittings. Precaution to be taken in storage and handling of oils. Study of pressure gauge, pressure selectors and filter units. Study of</p>	<p>Construction features, working principles and uses of pumps, positive and non positive displacement of pumps, gear pump, vane pump, piston pump, axial position and radial position pumps. Constructional features &amp; working principles of valves, types of valves directional control, pressure control, flow control. Direction control valves according to their spool position e.g. 3/4 Dc, 2/3 DC types of spool. Check valves, types of check valves-application-construction and use, pilot operated check valve. Servo valves block diagram of servo valve, mechanical servo, electrical servo, single stage spool servo, flapper type servo and jet type servo. Pressure control valve constructional features and working principles of simple relief valve-compound relief valve-("R" type relief valve-"R" type unloading valve-"R" type sequence valves-other types). Flow control valves constructional features and working principles of flow control valves and their uses. Meter in circuit, meter out circuit, bleeding off circuits.</p>	<p>Symbols of Pressure and flow sensors. Block diagram of servo motor.</p>	<p>Calibration of pressure and flow controls basic units of pressure &amp; converting units. Diaphragm gauges</p>
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	<p>pressure, float, flow switches, suction strainer, return line &amp; pressure line filters, Study of air oil cooler, water oil cooler, filler breather unit and tank accessories. Setting of various hydraulic elements for proper functioning. Repairs of hydraulic presses and various hydraulically operated equipment, fault finding by simulation.</p>	<p>Compensating features, pressure, temperature and flow. Actuators- constructional features and principles of hydraulic actuators. Hydraulic motor- Rotary actuators, hydraulic cylinders-types and their applications in hydraulic circuits, specifications cylinder cushioning. Study of stackable (modular) type hydraulic control valves. Study of manifolds, accumulator, intensifier, rotary joints etc. Study of machine tools application of the hydraulic drives for rotary, reciprocating, speed changing, clamping, unclamping and feed motions. Pipes and pipe work-types and selection-specification, material, bending of pipes, pipe bending fixture and pipe bending methods. Standard fittings of pipes e.g. ferrules, procedure for connecting pipe fitting work, installation of pipe, pipe storage. Flexible hoses-types and their specifications, uses according to the pressure in the line, correct insulation of flexible hoses and its importance. Constructional details, specification and uses of tank / reservoir, heat exchanger, heater,</p>		
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		<p>fitter/strainer, pressure gauge, intensifier, accumulators. Study of different types of hydraulic and lubricant oils. Introduction to seals and packing –types, their functions. Storage of seals. Fitters and their specifications. Methods of fault finding – rectification and remedies. Installation <b>commissioning</b>. Air venting and cavitations. Regular care of hydraulics.</p>		
11	-do-	<p>Friction –its effect, methods of reducing friction. Use of lubricants, use of bearings. Lubrication-need and use. How it is done. Qualities of a good lubricant-viscosity of the lubricant-main properties of lubricant.</p> <p>How a film of oil is formed in journal bearing. Methods of lubrication-by gravity feed, forced feed, splash lubrication Lubrication grooves and ring lubrication. Effect of a thick and thin lubricant. Lubrication of high and low speed drives. Common lubricating oil's and greases, their specifications and commercial names.</p> <p>Selection of lubricant.</p>	-do-	do



12	<p>Circuit building practice-use of shuttle valves for control, circuit for speed regulation of single and double acting cylinder, circuits for indirect control on single and double acting cylinders, time dependent control circuits etc. Study of machine tool applications of pneumatics Use in low cost automation, manipulators, material Handling equipment and pneumatic hand tools. Setting of pneumatic circuit elements for proper functioning – adjusting cushioning of the cylinders, flow, pressure etc. Repairing of pneumatic chisels, grinders, sanders, hammers, nut-spanners etc.</p>	<p>Constructional details, specifications, application of power unit, actuating unit, control unit.  Power unit-types of compressors-reservoirs, condensers, filters, service units.  Actuating units-single/double acting cylinders, rotary actuators, sander, disc grinder, nut runner etc.  Control units-directional control, pressure control and flow control valves.  Pipe and pipe fittings-materials, types, specifications and applications.  Types of seals, packing and glands.</p>	<p>Concept of co-ordinate axi in CNC, axi designation. X,Y,Z,A,B,C &amp; U,V,W. Application of coordinate axis in CNC</p>	--do--
13 & 14	<p>History of computer (first generation to fifth generation), classification of computers, characteristics of computer block diagram, representation of characters in computers. Demonstration and explanation of different input, output devices.  Study of computer memories-Ramom Access Memory, Read only Memory, Erasable Programmable Read Only, Memory, hard disk etc.  Study of central processing unit, structure of instructions, study of communication techniques between processor, input and output.</p>	<p>Background application, block diagram, input devices, output devices, CPU.  Memory - RAM,ROM,PPROM,EPRM.  Basic DOS commands, use of computer as CNC work station, communication between CNC &amp; computer</p>	<p>Input devices &amp; output devices. Block diagram of computer.ADC &amp; DAC circuit diagram.</p>	<p>Number system, binary, octal, hexa decimal conversion. Boolean algebra</p>

	<p>Study of disk operating system, basic DOS commands (e.g. DIR, MD, CD, RD, COPY, FORMAT, DEL saving of files etc.</p> <p>Explain use of computer as a CNC work station, communication between CNC &amp; computer communication hardware, software.</p>			
15 to 16	<p>Introduction to CNC technology. Study of special constructional and operational features with reference to driving mechanism, machine tool design, lubrication system. Familiarization with co-ordinate system, use of CNC codes and programming for simple test jobs.</p> <p>Manufacturing of simple jobs programmed on CNC trainer.</p> <p>Manufacturing of simple jobs programmed on CNC Trainer (contd.)</p> <p>Demonstrating the CNC machine features such as :-</p> <ul style="list-style-type: none"> <li>i) Flexibility, efficiency, repeatability.</li> <li>ii) Axis movement-rapid, feed, jog, manual data input modes, over travel limits .</li> <li>iii) Axis driving elements-Servomotors, gear box, ball screw, position feed back, open loop, close loop control, following error, position loop.</li> <li>iv) Reference point, referencing procedure.</li> <li>v) Execution of part programme without tool(DRY RUN), plotting/tracing of job profile on paper by executing</li> </ul>	<p>Introduction to CNC machines. Difference between NC, CNC and GPM Importance of CNC machines over other mass production processes.</p> <p>Constructional details &amp; working principles of CNC machines-machine beds-ball screw mechanism-servo drives-feed back mechanism etc.</p> <p>Axes designation.</p> <p>Introduction to G and M codes.</p> <p>CNC tooling and fixtures. Manual part programming.</p>	<p>Practice on secondary, auxiliary projections.</p> <p>Concept of co-ordinate axis in CNC.</p>	--do--

	part programme for two axes interpolation for 5 to 6 different components.			
17	<p>Study and practice of various CNC operating elements on CNC vertical machining centre.</p> <p>CNC operation-referencing (zeroing), part programming Use of M/S/T/G codes, and tool offsets, zero offset. Cutter radius compensation facilities. Precautions to be followed while executing commands and part programmes.</p> <p>Practice on CNC machining center incorporating all available facilities.</p>	<p>Spindle speed system: -</p> <ol style="list-style-type: none"> <li>1) True running of spindle assembly</li> <li>2) To withstand for radial and axial load.</li> <li>3) Types of spindle bearing-anti-friction, hydrodynamics, hydro statics.</li> <li>4) Pre-loading of spindle bearing.</li> <li>5) Temperature rise test of spindle for proper preloading, lubrication of spindle. Lube. oil cooler.</li> <li>6) Study of gear box and automatic speed range for constant power &amp; constant torque.</li> <li>7) Maintenance of same as mentioned above.</li> <li>8) Spindle orientation, de-clamping of tool from spindle head.</li> <li>9) Coolant through spindle and rotary joints.</li> <li>10) Coolant and chip disposal systems.</li> <li>11) Study of tool holding, de-clamping de-vices, is-scraping, air purging, tool cleaning.</li> </ol>	<p>Interpenetrating Curves of solids, Lines of intersection of plain surface to plain surface , (@2 sheets). Lines of intersection of plain surface to curved surface@ 2 sheets). Lines of intersection of curved surface to curves surface ) @ 2 sheets).</p>	<p>Pascal's law, their applications Gears-various types, terminology of gear teeth, simple and compound gearing</p>
18	<p>Introduction to CNC machine maintenance, use of maintenance card, history card &amp; recording the data.</p>	<p>Linear axis feed system: -</p> <ol style="list-style-type: none"> <li>1) Study of re-circulating ball screw.</li> <li>2) Basic elements of ball screw</li> </ol>	--do—	--do—

	<p>Reading and analyzing of CNC alarm message during machine operation.</p> <p>Preventive maintenance of machine such as checking of lubrication oil level, coolant level, hydraulic oil levels</p>	<p>(external &amp; internal)</p> <p>3) Pre loading of ball screw, tension &amp; compression of nut assemblies study of nut assembly.</p> <p>4) Assembly of ball screw.</p> <p>5) Maintenance of ball screw, proper lubrication, proper pre-loading to eliminate backlash, to reduce deflection &amp; to optimize stiffness.</p> <p>6) Guide ways, study of guide ways, LM &amp; turcite guide ways friction, anti-friction, hydrostatics &amp; centralized lubrication systems</p>		
19	<p>Study of :-</p> <p>Spindle speed system :-</p> <ol style="list-style-type: none"> <li>1. True running of spindle assembly with radial &amp; axial load.</li> <li>2. Types of spindle bearing – antifriction, hydrodynamics, hydrostatics.</li> <li>3. Pre-loading of spindle bearing .</li> <li>4. Temperature rise test of lubrication of spindle. Lube oil, cooler.</li> <li>5. Study of gear box and automatic speed range for constant power and constant torque.</li> <li>6. Maintenance of same as mentioned above.</li> <li>7. Spindle orientation, de-clamping of tool from spindle head.</li> <li>8. Coolant through spindle and rotary joints.</li> <li>9. Coolants &amp; chip disposal systems.</li> </ol>	<p>Study of :-</p> <ol style="list-style-type: none"> <li>1. Coolant and lubrication systems.</li> <li>2. Rotary axis, automatic tool changer pallet changer assemblies.</li> <li>3. Curvic coupling-to ensure indexing accuracy, to ensure mechanically high load bearing capacity.</li> <li>4. Clamping and De-clamping – clamping by disc, springs and de-clamping by Hydraulics or pneumatic.</li> <li>5. Drive to rotary table-using servomotor or hydrometer.</li> <li>6. Mounting of rotary encoder &amp; linear optical scale on the axis.</li> <li>7. Worm &amp; Worm Wheel to eliminate backlash.</li> <li>8. Turret on CNC lathes, automatic tool changer,</li> </ol>	--do--	--do--

	10. Study of tool holding, de-clamping device, de-spring , air purging, tool cleaning	spindle orientation. 9. Hydraulic clutch, tail stock, quill. 10. Accuracy & performance of CNC m/cs. Problem and remedies. 11. Inaccuracies such as backlash repeatability. 12. Counter balancing mechanism.		
20	Study of :- Linear axis feed system :- 1. Re-circulating ball screw. 2. Basic elements of ball screw(External & internal). 3. Pre-loading of ball screw, tension & compression of nut assemblies, study of nut assembly. 4. Assembly of ball screw. 5. Maintenance of ball screw- proper lubrication, proper pre-loading to eliminate backlash, to reduce deflection & to optimize stiffness. 6. Guide ways, study of guide ways, friction, antifriction, hydrostatic & centralized lubrication systems.	Hydraulic & Pneumatic power and circuits. Study of different hydraulic & pneumatic circuits Of CNC Turning, Milling, Grinding m/cs. Study of Hydraulic oil, air, coolant filtration system and hydraulic accessories.	Blue print reading conventions. Welding Symbols, surface roughness Symbols and their application . Tolerance of forms and positions and their applications (@ 4 sheets)	-do-
21	Study of “- 1. Coolant and lubrication systems. 2. Rotary axis, automatic tool changer pallet changer assemblies. 3. Curvic coupling- to ensure indexing accuracy, to ensure mechanically high load bearing capacity . 4. Clamping and De-clamping –	Study of :- 1. Electrical /electronic circuits for a CNC m/c. 2. CNC system hardware. 3. Feed and spindle drives. 4. Feed back devices. 5. Programmable logic controller 6. Safety interlocks.	-do-	-do-

	<p>clamping by disc, springs and de-clamping by hydraulic or pneumatic.</p> <p>5. Drive to rotary table- using servomotor or hydro motor.</p> <p>6. Mounting of rotary encoder &amp; linear optical scale on the axis.</p> <p>7. Worm &amp; Worm Wheel to eliminate backlash.</p> <p>8. Turret on CNC lathes, automatic tool change, spindle orientation.</p> <p>9. Hydraulic chuck tail stock, quill.</p> <p>10. Accuracy &amp; performed of CNC m/cs. Problem and remedies.</p> <p>11. Inaccuracies such as backlash, repeatability.</p> <p>12. Counter balancing mechanism.</p>			
22	<p>Hydraulic &amp; Pneumatic power source and circuits.</p> <p>Study of different hydraulic &amp; pneumatic circuits of CNC Turning, Milling, Grinding m/cs.</p> <p>Study of hydraulic oil, air, coolant filtration system and hydraulic accessories.</p>	-do-	<p>Exercise on solid geometry, ortho views, Development Intersection and auxiliary views (@ ¾ sheets)</p>	-do-
23 to 24	<p>Study of :-</p> <ol style="list-style-type: none"> <li>1. Electrical /electronic for a CNC m/c</li> <li>2. CNC system hardware.</li> <li>3. Feed and spindle drives.</li> <li>4. Feed back devices.</li> <li>5. Programmable logic controller.</li> <li>6. Machine power supply.</li> <li>7. Safety interlocks.</li> </ol>	CNC tooling and fixtures. Manual part programming		
25	Revision			
26	Examination			

**LIST OF TOOLS & EQUIPMNT**  
**FOR THE TRADE OF “Mechanic Mechatronic”**

**TOOLS AND EQUIPMENT FOR 16 TRAINEES + ONE**

**A : Trainees kit**

Sl. No.	Name of the items	Qty
1	Steel rule 300 mm graduated both side in Metric and English	17 nos.
2	Inside spring caliper 150 mm	17 nos.
3	Outside spring caliper 150 mm	17 nos.
4	Spring divider 150 mm	17 nos.
5	Hermaphrodite caliper 150 mm	17 nos.
6	Try square 150 mm	17 nos.
7	Hack saw frame adjustable 300 mm	17 nos.
8	Hammer Ball Peen with handle 200 gms.	17 nos.
9	Hammer Ball Peen with handle 400 gms.	17 nos.
10	Cold chisel 20 x 200 mm	17 nos.
11	Cross cut chisel 10 x 150 mm	17 nos.
12	Half round chisel 10 x 150 mm	17 nos.
13	Diamond point chisel 10 x 150 mm	17 nos.
14	Centre punch 100 mm	17 nos.
15	Prick punch 100 mm	17 nos.
16	File flat bastard 300 mm	17 nos.
17	File flat 2 <sup>nd</sup> cut 250 mm	17 nos.
18	File flat bastard 300 mm	17 nos.
19	File lat smooth 200 mm	17 nos.
20	Round Nose Plier 200 mm	17 nos.
21	Combination plier 200 mm	17 nos.
22	File half round 2 <sup>nd</sup> cut 250 mm	17 nos.
23	File three square smooth 200 mm	17 nos.
24	File round smooth 200 mm	17 nos.
25	File square smooth 200 mm	17 nos.
26	File needle set of 12 nos.	17 nos.
27	Scraper A 250 mm (Bearing)	17 nos.
28	Scraper B 250 mm (Triangular)	17 nos.
29	Scraper D 250 mm (half round)	17 nos.
30	Spindle blade screw driver 100 mm	17 nos.
31	Allen Hexagonal keys 2 to 16 mm	17 nos.
32	Card file	17 nos.
33	Scriber 150 x 3 mm (one side offset)	17 nos.

**B : TOOLS AND INSTRUMENT FOR MAINTENANCE SHOP**

Sl. No.	Name of the items	Quantity
1	Master bar 45 degree scraping bar 600 mm width of bar 75 mm, thickness 25 mm, all sides an accuracy of 0.02 mm seasoned.	1 no.
2	Master flat scraping test bar 600 mm, length 75 x75 mm sq. in cross section all sizes scraped to an accuracy of 0.02 mm per 300 mm seasoned.	1 no.
3	Tap and die M6 to M 12 with tap necessary tap wrench and die holder.	1 set
4	Spanner socket set of 25 pieces (10 to 25, 27, 30, 32 mm = 18 pieces and accessories = 7 Nos.	1 set
5	Pipe wrench 45 mm	1 no.
6	Chain pipe wrench 65 m	1 no.
7	Lubricant trolley 2400 x 1200 x 1200 mm (8 chamber)	1 no.
8	Cellepsable tool kit 5 compartments	1 no.
9	Tap extractor	1 no.
10	Stud extractor	1 no.
11	Granite surface plate 1600 x 1000 with stand and cover.	1 no.
12	CI surface plate 400 x 400 mm with wooden stand and cover	1 no.
13	Bearing and gear tester	1 no.
14	Three cell torch	1 no.
15	Gasket hollow punches 5, 6, 8, 10, 12, 19, 25 mm dia.	1 each
16	Bar type torque wrench	1 no.
17	Circlip pliers (inside and outside and straight)	1 set
18	Sledge hammer 5 kgs.	1 no.
19	Hammer soft (faced 30 mm dia. Plastic tipped)	2 nos.
20	Linear actuator (differential and non-differential)	1 each
21	Accumulator (spring and gas)	1 no.
22	Pneumatic tools (portable nut spanner/runner, chisel, grinder, sander and hammer.	1 each
23	Hydraulic, pneumatic trainer with necessary aggregates for different machine circuit with all type of transparent valves and pressure gauge, reservoir etc.	1 each trainer
24	Hydraulic valves (relief, sequence, unloading, pressure reducing, check, flow control, directional control valves etc.).	1 each
25	Transparent hydraulic cylinder	1 no.
26	Cut model of pneumatic valve	1 no.
27	Vibrometer	1 no.
28	Flow detector(magnetic crack detector)	1 no.
29	Engg. Stethoscope	1 no.
30	Tool picker collet type	1 no.
31	Tool picker magnet type	1 no.
32	Magnifying glass 75 mm	2 nos.
33	Pin spanner set	1 set
34	Solenoid valve	1 no.
35	Pneumatic meter	1 no.
36	Head lamp	1 no.
37	Master test bars (different size)	1 set
38	Level bottle (sprit) 150 ml.	1 no.
39	Cam lock type screw driver	1 no.
40	Flaring tool	1 no.



41	Self alignment roller ball bearing	1 no.
42	Telescopic gauges 13 mm to 300 mm	1 set
43	Gear pump	1 no.
44	Vane pump fixed and variable delivery	1 each
45	Piston pump (radial and axial)	1 each
46	Hydrometer	1 no.
47	Machine tool calibrator	1 no.
48	Lathe tool dynamometer	1 no.
49	Hand key way broacher	1 no.
50	Pneumatic scraper with adjustable stroke	1 no.
51	Hydraulic wheel and bearing puller	1 no.
52	Tube expander up to 62 mm	1 set
53	SRDG ball bearing, DRDG ball bearing, self aligning ball bearing, SRAC ball bearing, needle bearing, single row cylindrical roller bearing, tapered roller bearing, plain bush bearing, thin walled bearing.	1 each
54	Viscometer	1 no.

### C : PRECISION INSTRUMENT

Sl. No.	Name of the items	Qty
1	Vernier height gauge 500 mm	1 no.
2	Vernier bevel protractor with 150 mm blade	1 no.
3	Vernier caliper 200mm with inside and depth measurement	1 no.
4	Direct reading vernier caliper 300mm (direct reading with dial)	1 no.
5	Optical bevel protractor	1 no.
6	Outside micrometer 0 to 25 mm	1 no.
7	Outside micrometer 25 to 50 mm	1 no.
8	Outside micrometer 50 to 75 mm	1 no.
9	Outside micrometer 75 to 100 mm	1 no.
10	Combination set with 300 mm scale, center head, square head and protractor head	1 no.
11	Sine bar 200 mm	1 no.
12	Slip gauge metric set (for the whole institute)	1 set (box)
13	Internal micrometer 5 to 30 mm	1 no.
14	Vernier tooth caliper (metric)	1 no.
15	Bevel gauge 200 mm	1 no.
16	Dial gauge type 1 Gr. A (complete with clamping devices and stand)	1 no.
17	Feeler gauge	1 no.
18	Radius gauge (metric)	1 no.
19	Screw pitch gauge for metric pitches (0.25 to 6 mm)	1 no.
20	Center gauge 55 degree to 47 ½ degree	1 no.
21	Centre gauge 60 degree	1 no.
22	Plug gauge, plain	1 no.
23	Ring gauge Morse taper No. 1, 2, 3, 4	1 set
24	Ring gauge 5 to 25 by 2.5 mm (Go and No Go)	1 set
25	Limit plug gauges 5 to 25 mm by 2.5 mm	1 set
26	Wire gauge	1 no.
27	Bore dial gauge (0.01 mm dial)	1 no.
28	Indicator with magnetic base	1 no.

29	Straight edge 485 mm to 1445 mm	1 set
30	Adjustable micrometer spirit level to measure flatness, indication and taper with prismatic measuring base	1 no.

#### D : MACHINIST TOOLS

Sl. No.	Name & Description of items	Qty
1	Cylindrical milling cutter 63 x 90mm	1 no.
2	Side and face milling cutter 160 x 10mm	1 no.
3	Side and face milling cutter 160 x 10mm (inserted type)	1 no.
4	Slot milling cutter 10 x 6mm	1 no.
5	Single angle cutter 63 x 18 x 45 <sup>0</sup> (L.H.) and (R.H.)	1 each
6	Single angle cutter 63 x 18 x 60 <sup>0</sup> (L.H.) and (R.H.)	1 each
7	Equal angle cutter 45 <sup>0</sup> /100	1 no.
8	Equal angle cutter 60 <sup>0</sup> /100	1 no.
9	Slot drill ( Key seating ) 3,4,5,6,8,12 mm parallel shank	1 set
10	Slitting saw 80 x 3mm	1 no.
11	Slitting saw 100 x 4mm	1 no.
12	T-slot cutter to suit T headed bolt of 10, 12 mm Straight Shank	1 each
13	Convex milling cutter 4,10, 20 mm	1 each
14	Concave milling cutter 4,10, 20 mm	1 each
15	Corner rounding milling cutter 2.5, 4, 10, 16 mm	1 each
16	Woodruff key seating cutters 13.5 x 3, 16 x 4, 9.5 x 5, 19.5 x 6	1 each
17	End mill cutter Straight Shank 3, 6, 10, 12, 18, 22 mm	1 each
18	Milling gear cutter (involute) 1, 2, 2.5, 3 module set of 8 cutter	1 set
19	Fly cutter holder	1 no.
20	Scribing block universal 300 mm	4 nos.
21	V-block 100/7-80	1 pair
22	Straight edge (steel) 1000 mm	1 no.
23	Spirit level 2 V 250.05	1 no.
24	Spanner D.E. series 2	1 set
25	Table chuck 3 jaw with tightening arrangement and graduated in degrees	1 no.
26	Machine vice 200 mm swivel base	1 no.
27	Machine vice swivel base 160 mm	1 no.
28	Angle plate size 4 with slots	1 no.
29	Angle plate adjustable 250 x 150 x 175 mm	1 no.
30	Twist drill 3 to 13 mm (Straight Shank)	1 set
31	Twist drill 13 to 25 mm by 1 mm (Taper Shank)	1 set
32	Grinding wheel dresser (diamond) 1.5 carat	1 set
33	C-Clamp 150 mm and 200 mm	1 set
34	Hand reamer 6 to 25 mm by 1 mm	1 set
35	Punch letter set 4 mm	1 set
36	Punch number set 4 mm	1 set
37	Mandrel 120 mm long different sizes	1 no.
38	Wheel balancing stand with its accessories	1 set
39	Pin punch 3 to 10 mm by 1 mm	1 set
40	Deep cutting hack saw frame 300 mm	2 nos.
41	Machine reamer 6 to 25 mm by 1 mm	1 set
42	Engineers parallel	1 no.

**E : MASONARY**

Sl. No.	Name of the items	Qty
1	Man on chisel	1 no.
2	Four fold foot rule	1 no.
3	Plumb Bob	1 no.
4	Wooden straight edge 300, 600, 900, 1200 mm	1 each
5	Pick axes	1 no.
6	Bar bending tools and cutting tools	1 no.
7	Masons tool for plaster work	1 no.

**F : LATHE TOOLS**

Sl. No.	Name & Description of items	Qty
1	Drill chuck 30 mm	1 no.
2	Oil stone 150 x 50 x 25 mm	1 no.
3	Oil cane pressure feed 500 mm	1 no.
4	Boring tool holder (Armstrong) LH 8 and 10 sq. bit size x length 200 mm	1 no.
5	Tool holder 8 and 10 sq. bit size straight x length 200 mm	1 no.
6	Oil cane pressure feed 500 mm	1 no.
7	Reduction sleeve and extension sockets	1 each
8	Centre drill 1 to 5 mm	1 set
9	Revolving centers with Arbor	1 no.
10	Knurling tool with holder (straight, cross and diamond)	1 set
11	Lathe carriers up to 75 mm	1 set

**G : GENERAL MACHINE**

Sl. No.	Name & Description of machines	Qty
1	Lathe general purpose all geared height of center 150 mm to below, Gao bed between centers 1000 mm with all accessories with all attachment.	1 no.
2	Lathe general purpose all geared height of center 150 mm to below, between centers 1000 mm with 3 jaw and 4 jaw chuck, coolant equipments only.	1 no.
3	Milling machine, universal motorized No. 1 with all attachments.	1 no.
4	Surface grinding machine wheel dia. 180 mm (or near) reciprocating table, longitudinal table traverse 200 mm (or near) full motorized supplied with magnetic chuck 250 x 120 mm and necessary accessories.	1 no.
5	Drilling machine pillar 20 mm capacity	1 no.
6	Bench grinder 250 mm dia. (lighter type)	1 no.
7	Flexible hand grinder 100 mm dia. (lighter type)	1 no.
8	Portable drilling machine 6 mm capacity	1 no.
9	Tensile and Brinell hardness testing machine	1 no.
10	CNC Trainer	1 no.
11	Flexible hand grinder 100 mm dia. (lighter type)	1 no.
12	Portable drilling machine 6 mm capacity	1 no.
13	Cylindrical universal grinding machine	1 no.
14	Shaping machine 450 mm stroke (motorized) with all attachments	1 no.
15	Pipe bending machine (hydraulic)	1 no.

**H : MACHINE FOR REPAIR AND RECONDITIONING**

Sl. No.	Name & Description of machines	Qty
1	Old center lathe	1 no.
2	Old milling machine (universal)	1 no.
3	Tail stock	2 nos.
4	Old grinding machine (universal)	1 no.
5	Old shaping machine	1 no.
6	Old press (power)	1 no.
7	Old turret and capstan	1 no.
8	Universal indexing head	1 no.
9	Revolving center	1 no.
10	Gear box (old)	2 nos.

**I : WELDING WORK****a. (GAS WELDING)**

Sl. No.	Name of the items	Qty
1	Oxy-acetylene welding cylinder trolley	1 no.
2	Welding hose of P.V.C. flexible internal dia. 6 mm (blue, red)	5 nos.
3	Hose coupling nipples	1 no.
4	Hose protractor	1 no.
5	Double stage pressure regulator (oxygen) and double stage pressure regulator (acety.)	1 each
6	Blow pipe with tips high pressure	1 no.
7	Gas cutting torch with cutting tips	1 no.
8	Welding gloves pair (leather)	1 pair
9	Goggles (4A) for gas welding	3 nos.
10	Spark lighter	3 nos.
11	Spindle key	1 no.
12	Gas welding table with fire bricks	1 no.

**b : (ARC WELDING)**

Sl. No.	Name of the items	Qty
1	DC welding generator 150-300 amps. Complete to AC induction with all accessories	1 no.

**J : HEAT TREATMENT**

Sl. No.	Name of the items	Qty
1	Blacksmith's Anvil, 200 kg.	1 no.
2	Smiths tongs hollow bit, Smiths tongs flat (30 mm)	1 each
3	Water tank (450 x 300 x 250 x 6 mm)	1 no.
4	Brass rule 300 mm	1 no.
5	Furnace for heat treatment	1 no.
6	Oil bath (for quenching) 45 x 45 x 45 6 mm thick plate	1 no.

**K : SHEET METAL WORK**

Sl. No.	Name of the items	Qty
1	Forge power operated 45 mm dia 150 mm blower	1 no.

2	Soldering copper bit 450 gm	1 each
3	Metal cutting shears 300	1 no.
4	Mallet (plastic or rose wood) ord. And rectangular 75 x 75 x 50 mm	1 no.
5	Conical mallet	1 no.
6	Half moon stake	1 no.
7	Beak iron	1 no.
8	Funnel stake	1 no.
9	Hatchet stake	1 no.
10	Snap rivet set A-3, A-4	1 no.

#### **L ; FURNITURE**

Sl. No.	Name of the items	Qty
1	Metal lockers 8-lockers type with individual locks 1980 x 910 x 480 mm	1 no.
2	Metal office chair with arm, cane sit and back	1 no.
3	Metal office table with three drawers	1 no.
4	Work bench	2 nos.
5	Metal shelving rack open type 1800 x 900 x 500 mm with adjustable shelves	2 nos
6	Drawing desk	1 no.
7	Stool	1 no.
8	Black board with easel milky glass with graph line	1 no.
9	Portable fire extinguisher	1 no.
10	Galvanized milled steel fire bucket 4 liters	2 nos.

#### **M : ELECTRICAL TECHNOLOGY AND ELECTRONICS**

Sl. No.	Name of the items	Qty
1	Screw driver electrician 150 mm	17 nos.
2	Screw driver Philips Nos. 860, 862, 862	17 nos.
3	Long nose plier 150 mm insulated	17 nos.
4	Combination plier 150 mm	17 nos.
5	Diagonal cutter 150 mm	17 nos.
6	Tweezers	17 nos.
7	Knife 100 mm	17 nos.
8	Neon tester	17 nos.
9	Scissors 150 mm	17 nos.
10	Soldering iron 25 W	17 nos.
11	Soldering iron 65 W	17 nos.
12	Multimeter	2 nos.
13	Ammeter 0 mA to 500 mA	1 no.
14	Ammeter 0-1 A DC	1 no.
15	Voltmeter 0-300-600 V AC	1 no.
16	Discrete component trainer	1 no.
17	P.F.Meter	1 no.
18	Frequency meter	1 no.
19	Megger 500 V	1 no.
20	AC squirrel cage induction motor 30 with D.O.L. starter	1 no.

21	Star delta 30 starter	1 no.
22	C.T. single phase	1 no.
23	P.T. single phase	1 no.
24	Auto transport 0-300 V, 8 Amp.	1 no.
25	C.R.O. 50 MHZ	1 no.
26	Digital I.C. tester	1 no.
27	Digital I.C. trainer	1 no.
28	Audio signal generator	1 no.
29	DC power supply 0-30 V, 2 Amp.	1 no.
30	Demonstration model for thyristorised DC motor drive (1 HP) set up	1 no.
31	Demonstration model for thyristorised AC motor drive (1 HP) set up	1 no.
32	Linear I.C. trainer	1 no.
33	Digital multi-meter 2.5 Amps./5 Amps	1 no.
34	Transducer	1 no.
35	Thermocouple kit	1 no.
36	L.D.R.S. kit	1 no.
37	Thermister kit	1 no.
38	L.V.D.T. kit	1 no.
39	Strain gauge	1 no.
40	Photo diode	1 no.
41	Photo transistor kit	1 no.
42	AC timer kit	1 no.
43	DC timer kit	1 no.
44	Decimal counter kit	1 no.
45	DC motor control kit	1 no.
46	Hand tachometer	1 no.
47	Ammeter portable type 0-15 Amps. AC	1 no.
48	Insulated handle screw driver 200 mm	2 nos.
49	Insulated handle combination side cutting plier 200 mm	2 nos.

#### **N : HOISTING EQUIPMENT**

Sl. No.	Name of the items	Qty
1	Forks clips 02 tonnes (copa)	1 no.
2	Forks clips 05 tonnes (copa)	1 no.
3	Manila ropes 12, 20, 30 mm dia.	1 each
4	Crow bar	2 nos.
5	Rollers (steel tubes) from 40 to 65 mm dia.	5 nos.
6	Block of timber (various sizes)	5 nos.
7	Portable jack	1 no.
8	Carge winches 3, 5 tonnes	1 no.
9	Wall hoists	1 no.
10	Traveling and gantry cranes	1 no.
11	Shear legs (tripod)	1 no.
12	Hand operated chain pulley block	1 no.
13	Mobile crank	1 no.
14	Conveyor	1 no.
15	Elevators	1 no.
16	Ratchet chain pulley	1 no.

**O : ERECTION TOOLS AND EQUIPMENT**

Sl. No.	Name of the items	Qty
1	Foundation bolt	4 nos.
2	Plumb bob	1 no.
3	Square box wrenches	1 no.
4	Square T-wrenches	1 no.
5	Engineers square 700 mm	1 no.
6	Threaded fastener type B	1 no.
7	Threaded fastener type C	1 no.
8	Threaded fastener type F	1 no.