

SYLLABUS
FOR THE TRADE OF
MECHANIC MECHATRONICS

(Previously designated as –MECHANIC ADVANCED MACHINE TOOL MAINTENANCE)

Under

CRAFTSMEN TRAINING SCHEME
AND
APPRENTICESHIP TRAINING SCHEME

Designed in 2000

Government of India
Ministry of Labour (DGE&T)
CENTRAL STAFF TRAINING & RESEARCH INSTITUTE
EN Block, Sector-V, Salt Lake, Kolkata-700091

**List of members attended the Trade/Expert Committee meeting for finalization for the syllabus for the Trade of “MECHANIC
MECHATRONICS’ held on 14.6.2000**

S/Sri

1. S.R. Majumdar,	Director, CSTARI., Kolkata	Chairman
2. S.V.Gokhale	Div. Manager, TELCO, Pune	Member
3. R.M. Sinha	JDT, CSTARI, Kolkata	Member
4. H.Bhattacharya	TTC/CLW/Chittaranjan	Member
5. P. Nayak,	Sr. Instructor, STC/KPA	Member
6. A. Goswami	Sr. Lecturer, System Tech. School E. Rly. Kanchapara	Member
7. B.C.De	C & W Workshop , Liluah, E.Rly.	Member
8. A.K.Majumdar	-do-	Member
9. M.K.Majumdar	ATI, Dasnagar, Howrah-5	Member
10.M.K.Saha	G.R.S.E. Ltd., Kolkata	Member
11. A.S.Giri	TISCO Ltd., Jamshedpur	Member
12. B.K.Binayagam	TISCO Ltd., Jamshedpur	Member
13. A.K.Pal	DDT., RDAT (ER) Kolkata	Member
14. M.S.Saha	ITI., Purulia	Member
15. S.Bhattacharya	CESC Ltd.,	Member
16. S.K.Das	ADT, CSTARI, Kolkata	Member
17. H.Das	T.O. CSTARI., Kolkata	Member
18. M.B. Kerketta	T.O. CSTARI., Kolkata	Member

GENERAL INFORMATION

- | | | |
|----|-------------------------------------|--|
| 1. | Name of the trade | : MECHANIC MEAHCTRONICS
previously designated as MECHANIC ADVANCED MACHINE TOOL
MAINTENANCE (Under CTS) |
| 2. | N.C.O.Code No. | : 845.63 |
| 3. | Duration of Craftsmen Training | : Two Years |
| 4. | Duration of Apprenticeship Training | : Three years including two years Basic Training |
| 5. | Entry Qualification | : Passed 10+2 with Physics, Chemistry & Mathematics or its equivalent |
| 6. | Rebate for Ex-ITI Trainee | : Two years for ITI/MTI passed trainees in the trade of Mechanic Mechatronics |
| 7. | Ratio of Apprentice to Worker | : 1:7 |

WEEK-WISE BREAKUP OF SYLLABUS FOR THE TRADE OF

MECHANIC MECHATRONICS

(Previously designated as –MECHANIC ADVANCED MACHINE TOOLS MAINTENANCE)

UNDER THE CRAFTSMEN TRAINING SCHEME

PERIOD OF TRAINING – Two Years

Week No.	Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
1.	<p>Familiarization with institute & work place. Importance of the Trade Training, Types of the work done by the Trainee & role of “MEAHCNIE ADVANCED MACHINE TOOL MAINTENANCE” in an industry. Rules & regulations of the institute. Allocation of workplace. Issue of tool box & essential tools.</p> <p>Importance of Cleanliness & orderliness at the workplace.</p> <p>General Safety Rules.</p> <p>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.</p>	<p>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.</p> <p>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 house keeping, 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.</p>	<p>Composition & Resolution of forces ,Lami’s Theorem, condition of Equilibrium.</p>	<p>Introduction to graphical language and use of drawing instruments.</p>

2.	<p>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 of simple measuring instruments such as Steel Rule, Vernier caliper, inside/outside Micrometer. Care and precautions to be observed in handling these instruments. 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, scriber, marking blocks & 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 ± 0.5 mm. Marking location of the centers of circle by drawing horizontal & vertical line & then scribing circles using dividers. Use of Dot & Centre punch for punching the lines, centers & circles.</p> <p>Layout the dimensional features of the work piece using vernier height gauge, engineering Square, angle plate & surface plate.</p>	<p>Introduction to measuring & checking instruments. Non-precision linear measurement by using steel rule, depth rule, hook rule & zigzag rule, bit rule, tape etc.</p> <p>Measurement by using firm joint caliper, spring joint caliper, adjustable bevel protractor & combination set etc.</p> <p>Measurement with precision instrument : Vernier calipers- principle & construction, reading a vernier caliper, care & maintenance etc.</p> <p>Vernier Bevel Protractor.</p>	-do-	BIS standard size drawings sheet. Free hand sketching practice of horizontal and vertical lines.
----	---	---	------	--

3.	<p>Balancing of file using rough file to be continued on channel. Filing flanges of a channel for practicing of filing. Filing flat surface & flanges of a channel maintaining parallelism between them using outside calipers within + or –0.5mm</p>	<p>Work bench, bench vice-constructural details, different types of vices, their uses, care and maintenance of vices.</p> <p>Files:- File parts & material classification of files based on grade, cut, shape, length etc.</p> <p>Printing of file, Convexity of file- reasons, reconditioning of files, file care & its uses.</p> <p>Methods for steady & accurate filing-no. of strokes per minute, right method of fixing file handle, care & maintenance of files.</p>	-do-	Free hand sketching practice of inclined lines and polygons, rectangles, squares etc.
4 & 5.	<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> <ol style="list-style-type: none"> Flatness & square ness of adjacent faces using tri-square Parallelism between opposite sides. <p>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 + or- 0.1 mm using Vernier Caliper.</p> <p>Filing with second cut files to prepare smooth surfaces.</p>	<p>Introduction to layout marking, making media & marking tools-construction, use, care and maintenance.</p> <p>Procedure of marking. Types of marking operations. Equipment and instruments:- Construction, use, care & maintenance of surface plate, marking table, scribe, dividers, surface gauges, angular plate, marking block, V block & clamp. Hermaphrodite caliper. Engineering square, parallel block, “C” clamp, tool makers clamp, combination set, bevel square etc.</p> <p>Introduction to punches, material, uses and care of various types of punches such as center punch, dot punch etc.</p> <p>Letter & number punch set. Pin & Hollow punches. Hammer parts, types, specification & uses of hammers. Fitting the handle to the hammer head , precautions/care & maintenance.</p> <p>Types of hacksaw frames special frames. Different parts. Types of Hacksaw blades</p>		

		material, specification & uses. Reasons for breaking of Hacksaw blades. Care & maintenance, points to be observed while hack sawing to avoid breakage blades. Safety to be observed while hacks awing.		
6.	<p>Marking of profiles-combination of straight lines, circles, arcs & angles. Use 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 & 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 & slot fitting. Cutting of sheet metal with chisel.</p>	<p>Types of Chisels-material, specification & application. Hot Chisels & Cold Chisels. Different cutting angles & their importance. Method of Chipping & safety precautions to be observed while Chipping. Use of proper Hammer. Grinding-Sharpening of Chisel on bench grinding machine.</p>	Friction – static & dynamic friction, Laws of friction.	Orthographic Projection, Directional Views by Orthographic Projection method.
7.	Hammering practice on vertically held round job. Blind hammering practice .Stamping Letters & Numbers on M.S. plates. Exercise on stamping to develop judgement, control on hand & feel. Stamping practice on flat & round	Types of Drills –nm Flat & Twist Drills, straight fluted & special types of drills, parallel & taper shank drills construction/material & use. Nomenclature of flat & twist Drill- specification of Drill, Drill angles & their importance, advantages & disadvantages of flat & Twist	-do-	First angle method of projection.

	surfaces. Use of cross Peen 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.	Drills. Drill Grinding- sharpening of Drills, Web thinning – checking and round drill, common faults- mistakes & their ill-effects. Cutting speed & feed- setting/selection for various operations. Counter boring, spot facing & counter sinking operations of Drilling machine. Cutting fields (Coolants) used in drilling.		
8.	<p>Introduction to Drills. Preparations for drilling. Marking out the position of holes & Dot punching. Deepening the points with center punch. Checking for center distance.</p> <p>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 & filling to produce square, round & triangular openings on 6 mm thick plate. Preparing inserts by hack sawing & filing.</p> <p>Fitting inserts in the respective openings-exercise on step & angular fitting.</p>	<p>Introduction to drilling machine – Portable & Hand Drilling Machine. Bench and Pillar-Upright type drilling machine.</p> <p>Study of drill holding devices. Drill chuck, chuck key, drill drift, sockets & sleeves-construction, material & use.</p> <p>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.</p> <p>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.</p>	-do-	Third Angle method of projection.
9.	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	<p>Introduction to reamers, types of reamers, pitch of flute, precautions to be observed while reaming.</p> <p>Allowances for reaming, coolant used while reaming. Floating holders for reamers.</p>	Center Gravity & centroids of various figures and bodies	Compares on of first angle and third angle

	<p>sinking, counter boring & spot facing operations using bench drilling machine. Exercises on Reaming with hand reamers & machine reamers.</p> <p>Internal threading by hand using Tap Sets. External threading by split die & finishing of thread by Die nut. Marking centers on two and end faces of a round bar with the help of “V” block & clamp. Drilling & Reaming of blind holes along the axis of round jobs.</p> <p>Grinding of drills & chisels to specifications & checking of angles with gauges.</p>	<p>Construction & use of Hand Reamers, expansion reamers, adjustable reamers, taper reamers, rose reamers, chucking reamers etc.</p> <p>Elements & forms of screw threads. Single and multi-start threads, right & left hand threads. Hand and machine taps, sizes, tapping on different types of materials, Lubricants for tapping- tapping blind holes. Reasons for breakage of taps & 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 & handles. Methods of thread cutting with die & die stock. Setting the threading die. Use of lubricants. Use of hand chasers & machine chasers.</p>		
10.	<p>Exercise on filing – Radius & Angular filing using templates & gauges.</p> <p>Filing Templates & gauges for checking. Lathe tool angles. Filing to an accuracy of + or – 0.1 mm., checking with Vernier Caliper. Preparation of plates for gauge fitting.</p> <p>Filing of various angles & clearances of lathe tools on square blanks. Checking with templates & Gauges already prepared.</p> <p>Measurement of shaft & hole diameters using outside & inside micrometer.</p> <p>Filing round on square bar within + or –0.1 mm.</p>	<p>Elements of interchangeable system.</p> <p>Definition of Limit, Tolerance & Allowance. Basic dimensions or sizes. How Limit & Tolerance is denoted ? Application of tolerance. Tolerance of Form & Position. Use of symbols. System of Tolerance & Limits, ISI 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 & interference.</p>	-do-	Practice on First Angle and Third Angle, method of projection with only vertical and horizontal surfaces @ 5 sheets,)

		<p>Component assembly such as, Free Fit Med. Fit Snug fit, Wringing fit, Tight fit, Medium force fit, Shrinkage fit etc.</p> <p>Interchangeability & standardization, method of selective assembly, hole & shaft basis of system.</p> <p>Micrometer- inside & outside – constructional features, Principle operation, graduations, reading – use, care & maintenance.</p> <p>Purpose, types, construction, function and method to use comparators.</p>		
11.	<p>Use of Combination & Round Nose Pliers to make different shapes/profiles by bending wire to match the blue print to develop manipulative skills, hand control & eye judgment</p> <p>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 & care to be taken in using these tools.</p> <p>Cold riveting. Marking out location & drilling of holes for riveting. Use of dolly & snap for forming rivet heads. Lap & Butt Joint by cold riveting.</p>	<p>Types of spanners-their material & uses-Box, Socket, Tubular, hook spanner etc.</p> <p>Wrenches – material & use of T Socket, Monkey, Ratchet, Pipe wrenches etc.</p> <p>Types of screw drivers- materials & uses.</p> <p>Types of Pliers- Material & uses, combination pliers, Long nose pliers, flat nose pliers circlip pliers etc. Fasteners & 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.</p> <p>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>	-do-	-do-

		<p>Merits & demerits with examples, advantages and disadvantages of using each one- where generally used and why?</p> <p>Keys & cotters – Classification & comparison of keys & cotters.</p> <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.	<u>Project work</u> : making parallel clamp “C” clamp or micro meter stand by using acquired skills.	<p>Scrapping- 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 & their correct use/application- use of surface plate, straight edge, angle plate, master cylinder in the process of scraping.</p>	<p>Stress, strain Hook’s law, elastic limit, ultimate stress, modulus of rigidity, Poisson’s ratio, temperature stress, resilience etc.</p>	-do-
13.	Scraping on flat surface. Taking impression for high spots using Persian blue. Sharpening of scrapers using diamond wheel & lapping stone.	<p>Properties & 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>Practices to be considered in selection of materials – strength , rigidity, resistance to fatigue, damping</p>	-do-

		Plastic deformation of materials – Cold & Hot Bending- Bending- Bending of Strips. Change in mechanical properties of material in Hot & Cold Bending. Meaning of tenacity, elasticity, malleability, ductility, toughness etc. With special reference to practical application –use of various engineering materials.	capacity, corrosion resistance etc.	
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-	-do-	Practice on single slant surface and double slant surfaces as per orthographic projection method.
15.	Application and use of dial indicators, slip gauges and height gauge/height master. Application of various measuring instruments to measure of a component.	-do-	--do-	-do-
16 & 17.	<u>Application of Advanced Bench Working Skills</u> 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 pipes-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 &	Elasticity, Ductility, malleability, Plasticity, Brittleness, Toughness, Hardness, Creeping, Creep stress, Fatigue stress,	-do-

		<p>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.</p> <p>Pipe cutting using pipe cutter. Pipe threading & piping using various pipe fitting such as “T” fitting, elbow fitting, reducers etc.</p> <p>Punching of holes on leather with hollow punches.</p> <p>Preparation of gaskets & other packing materials.</p> <p>Standard pipe threads, cutting of pipe threads using Dies & taps.</p> <p>Care and precautions to be observed while using pipe vice, pipe wrenches, dies and taps.</p> <p>Standard pipe fittings- Methods of fitting & replacing the fittings.</p> <p>Methods of protecting leaks all the joints.</p> <p>House Hold piping- standard pipe fittings.</p> <p>Fullering practice & ferrule fitting.</p>	Impact stress etc. of metal	
18.	<p>Filing flats on cylindrical parts. Filing square at the end & in the middle of cylindrical rod within + or –0.04 mm.</p> <p>Introduction to lapping process. Laps & lapping pastes, procedure for charging lap. Use of kerosene in lapping. Lapping on flat & cylindrical (internal and external) surfaces.</p>	<p>Micro-meters- special types- important features & applications. e.g. Thread checking micrometer, flange Micrometer, Depth Micrometer etc.</p> <p>Sine bar, slip gauges- its principle of working & applications. Purpose and method to use similar & slip gauges and rollers.</p>	-do-	-do-
19 & 20.	<p>Bending of solid sections by using bending fixtures, bending dies etc.</p> <p>Cold & Hot bending of pipes of different diameters of ferrous metal i.e. hydraulic pipes</p>	<p>Types of gauges- Plug , Ring, Snap, Taper, feeler, screw Pitch, Radius & sheet metal gauges.</p> <p>Dial indicators- construction & use. Various types.</p>	-do-	Lettering practice vertical style as per ISI.

	<p>& non-ferrous metals i.e. copper tubes for lubrication system. Pipe bending with or without filling in fine sand. Use of pipe bending fixture to maintain uniform bending radius. Precautions to avoid wrinkles. 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 materials. Fullering practice & ferrule fitting.</p>	<p>Comparators – Electrical, Optical pneumatic construction & working principles. Definition of surface finish. Terms used to describe the surface finish. Dimensional Tolerance of surface finish according to ISI. Surface quality & its symbolic representation. Equipment used for testing/measuring surface quality. Units of surface finish. Surface finishing processes, lapping, honing, electroplating, metal spraying, galvanizing, picking and Metallisation.</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 & 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 & fitting key ways. Making different types of keys & key ways on pulleys, gears etc. by hand.</p>	<p>Definition of lapping & 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 & 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 & 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>	-do-	<p>Lettering practice inclined style as per ISI. Types of Lines and application.</p>
23.	<p>Familiarization and use of different types of ropes such as hemp, manila, nylon, wire etc.</p>	<p>Specification and use of different types of ropes such as hemp, manila, nylon, wire etc. Practicing</p>	-do-	<p>Dimensioning technique &</p>

	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.	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.		systems in dimensioning. General rules in dimensioning.
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.	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.	-do-	-do-
25.	Use of hoists and cranes for lifting purpose. Constructional features and working principles. Methods lifting jobs of various shapes, sizes and weights. Use of appropriate length of chains. Inspection of chain links.	-do-	-do-	Practice on dimensioning (@ 2 sheets.)
26.	Revision & Test	Revision & Test	Revision & Test	Revision & Test

27.	<p>Constructional features and working principles of Lathe machine.</p> <p>Functional relationship of various parts of the machine.</p> <p>Study of the gear box and drives used on the machine.</p> <p>Study the methods of holding work piece and tool using different devices.</p> <p>Exercises on plain, stepped, taper and form turning, knurling etc.</p> <p>Exercises on drilling, reaming, boring counter boring etc.</p> <p>Screw thread cutting both external and internal of different types.</p> <p>Exercises on eccentric turning.</p> <p>Grinding of Lathe tools.</p> <p>Care and maintenance of machines.</p> <p>Safety precautions to be observed while handling machines.</p> <p>Study of lubrication system and preventive maintenance.</p> <p>Simple projects such as hollow punch, pulleys, gear blanks, simple couplings etc.</p>	<p>Metal cutting and cutting tools. Introduction to metal cutting.</p> <p>Mechanism of metal cutting- orthogonal and oblique cutting, chip formation, types of chips and chip breakers.</p> <p>Cutting tool geometry and nomenclature, control of angles, tool life.</p> <p>Cutting speed and feed and its calculation.</p> <p>Properties and uses- cooling system types – soluble oils-soaps, paraffin, soda water etc. bio-degradable oil.</p> <p>Effective of cutting fluids in metal cutting.</p>	<p>Ferrous materials-pure iron, cast iron, wrought iron & steel-manufacturing Process, composition and uses.</p> <p>Crystallography structure , iron carbon diagram & heat treatment of iron and steel.</p>	<p>Exercise on first angle, third angle with dimensioning (@ 5 sheets)</p>
28 to 30	-do-	<p>Constructional features, types, functions and use of Lathe machine.</p> <p>Study of Lathe accessories – face plate, chucks, steadies their use.</p> <p>Driving mechanism – Gear box mechanism-gearing, common lathe tools-their names, materials and use, cutting tool angles, grinding of lathe tools.</p> <p>Common lathe operations- chucking, centering,</p>	-do-	-do-

31	<p>Constructional features and working principles of shaping machine.</p> <p>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>plain turning, facing and boring, taper calculations – screw cutting.</p> <p>Cutting speed and feed, use of coolants.</p> <p>Care and maintenance- preventive maintenance.</p>	-do-	<p>Introduction to sections and sectional views. Different types of sections used in engineering drawing. Conversions used in engineering drawing.</p>
32 to 35	<p>Constructional features and working principles of Milling Machine.</p> <p>Functional relationship of various parts of the machines.</p> <p>Study of gear box and drive used on the machine.</p> <p>Study of different work and tool holding devices.</p> <p>Exercises on parallel and angular milling.</p> <p>Exercises on grooving using end mills.</p> <p>Cutting of gears-spur and helical using simple indexing.</p> <p>Use of slotting attachment for cutting keyways.</p> <p>Care and maintenance of machine.</p>	<p>Constructional features and working principles, types, functions, use of milling machines, attachment and accessories.</p> <p>Different methods of holding work piece and cutters.</p> <p>Common milling operations such as plain, step, angular milling, slot and groove cutting, use of dividing head for indexing-types.</p> <p>Various types of gears and elements gears. Gear cutting and Cam cutting.</p> <p>Various speed and feed. Use of coolant for different materials.</p> <p>Detection of common faults-detects and their rectification. Safety precautions.</p> <p>Care and maintenance-preventive maintenance of</p>	--do—	<p>Different sectional view, exercises (@ 5 to 6 sheets).</p>

	<p>Safety precautions in handling machine.</p> <p>Study of lubrication system and preventive maintenance.</p> <p>Simple project such as jaw, claw, Oldham coupling, spline cutting etc.</p>	<p>milling machines.</p>		
36&37	<p>Constructional features and working principles of surface and cylindrical grinding machines.</p> <p>Functional relationship of various parts of the machine.</p> <p>Study of drive-both mechanical and hydraulic.</p> <p>Study of different work holding devices.</p> <p>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>Constructional features, types, functions and use of grinding machines.</p> <p>Grinding wheels and their specifications-grit, grain size, structure, bond, grades etc.</p> <p>Use of grinding wheels, balancing and truing.</p> <p>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.</p> <p>Safety precautions to be observed in grinding operations.</p> <p>Care and maintenance-preventive maintenance of grinding machines.</p>	--do—	--do—
38	<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>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, scribes, trammels, dividers etc.</p> <p>Simple developments and method of laying out.</p>	--do—	<p>Missing views and practice on above portion. (sectional view exercise).</p>

	<p>Practice on lap joint, lock grooved joints and hammering.</p> <p>Cutting practice with different snips, cutting of notches, inside and outside curves.</p> <p>Sheet metal cutting on shearing machine.</p> <p>Safety in operations.</p> <p>Forming rectangular, round and conical shapes using stakes.</p> <p>Removal of dents and simple hollowing practice.</p> <p>Use of hard and soft solder.</p> <p>Soldering practice on ferrous and non-ferrous metals.</p> <p>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>Types of joints-folded joint, grooved and beads etc.</p> <p>Soldering, sweating, brazing and tinning-materials and method employed.</p> <p>Soft and hard solder-their composition, properties and use.</p> <p>Fluxes and spelters-importance and use.</p> <p>Soldering iron-types and uses.</p> <p>Preparing the job for soldering, method of soldering.</p>		
39&40	<p>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.</p> <p>Measurement of co-ordinates, center distance, angle, centricity, eccentricity, dovetail slot etc. by using :-</p> <ol style="list-style-type: none"> Lever type dial indicator and slip gauge. Liver type indicator and height master. Dial indicator and rollers and pins. 	<p>Inspection, quality control, quality assurance, total quality management concepts and quality awareness.</p> <p>Zero defect, self inspection and applications.</p> <p>Statistical process control:-</p> <ol style="list-style-type: none"> control charts chance causes and assignable causes plotting of control chart various type of trends. 	--do—	--do—

	<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. Construction and use of various control charts. Detection of chance and assignable causes and study of various trends.</p>			
41to43	<p>Working principles of Arc, gas and spot welding machines.</p> <p>Connecting and setting of machine for operation. 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. 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 maintenance of welding equipment.</p>	<p>Gas and electric welding – tools and equipment. Principle of fusion welding. Types of joints and method of welding. Safety precaution and maintenance of equipment. Welding defects – causes and how to avoid them. Flame cutting – principle and use of equipment.</p>	--do—	<p>Dimensioning, sectioning and practice sheets. (@15/16 sheets).</p>
44to47	<p>Safety precautions applicable to electrical trade. Grinding of wire as per ISI and cables, colour coding used on them. Removal of insulation of wires/cables and soldering free ends of copper strands.</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</p>	--do-	--do—

<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 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,</p>	<p>electromotive force, voltage current and resistance. Electrical safety rules and precautions. Ohm's Law and Kirchhoff's 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/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>		
--	--	--	--

	<p>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>			
48to51	<p>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 out look. Types, specifications and general applications of these components. Testing and measurement of their values using multi-meter. Use of resistance colour codes. Soldering and desoldering of component on and from printed circuit boards (P.C.B.). 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 devises 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.</p>	<p>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 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.</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.</p>	<p>--do—</p>
52	<p>Revision & Test</p>	<p>Revision & Test</p>	<p>Revision & Test</p>	<p>Revision & Test</p>

53to55	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.	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.	Selection of motors, DC and AC motors, types of starters and various methods of starting.	Lettering practice (Vertical & Inclined). Geometrical constructions bisecting lines and angles, to make equal division of a straight line.
56	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.	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.	--do--	Geometrical constructions polygons in circles.

57to59	<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 leveling 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 against vibration. Anti-vibration devices and their locations. Different types of instruments used for checking the vibrations. Leveling machines, importance of leveling. Methods of grouting. Use of machine leveling screws. Methods of leveling, precautions to be taken while leveling, leveling accuracy – its measurement. 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>	--do—	<p>Geometrical constructions on inscribed circles in polygons. Geometrical constructions on described circles in polygons. Geometrical constructions on tangential arcs and circles.</p>
60&61	<p>Study for 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</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. Special precautions</p>	<p>Semi-conductor theory, diodes, transistors and thyristors. Boolean algebra, logic</p>	<p>Preparation of templates by using tangential arc method. Engineering curves –</p>

	<p>needed. 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>necessary for erection, leveling and aligning precision machines. Testing for correct functioning of machine parts, machine commissioning.</p>	<p>gates, flip flops.</p>	<p>parabola and hyperbola.</p>
62	<p>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.</p>	<p>Prime movers. Types of drives-Rope & Chain. Variable speed transmission PIV drives and Harmonic drives. Friction drives. Clutches-positives 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.</p>	<p>--do--</p>	<p>Ellipse 4 types of constructions @ 2 sheets.</p>
63	<p>--do--</p>	<p>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.</p>	<p>--do--</p>	<p>Exercise on sectional views.</p>

64	<p>Inspection of machine guide ways and slides. Checking for straightness, flatness, scoring/scuffing marks and 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. Mechanism to be studied-</p> <p>-Lathe machine-carriage, apron, feed box, head stock etc.</p> <p>-Milling machine Feed box(column, knee, saddle,) rapid traverse gear box, intermediate gear box etc.</p>	<p>The object of belts-Types/sizes/specifications and uses. Materials used for belts-leather, cotton, 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 & disadvantages of each other.</p>	--do--	Construction on involutes.
65	<p>Familiarization with plain/journal bearings, anti-friction bearings used on machine assembly. Specification & selection for appropriate use. Use of manufacturers catalogues.</p> <p>Mounting of bearing on shafts and in housing with proper fit & axis alignment. Use of proper tools. Removal of bearings from shafts & housing by using pullers. Cleaning up & removing old metal from bearing and replacing with new metal. Scrap & 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 & driving tension in a belt. Parallel & cross belt drive, open & 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 & 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. Hook's coupling, Universal coupling, Flexible couplings their different uses. Friction and Universal coupling advantages and disadvantages over each other & their applications. Types and uses, their function</p>	--do--	Construction of cycloidal curves-cyc;pid, epicycloids, hypo-cycloid and Archimedean spiral.

		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 & uses of key pullers. Use of keys in power transmission.		
66	Study of Various machine tools such as Lathe, Milling Grinding & 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.	Types-materials and uses of gears. Various manufacturing processes. Study of spur gear elements-tooth profile-pitch circler-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 & tear of the toothed wheels & their remedies. Methods of fitting spiral gears, helical gears, bevel gars, worm and worm wheels in relation to required drives. Care and maintenance of gears.	--do--	--do--
67	--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 housing. Method of	--do--	Construction of Helix on cylinder and on cone.

		mounting and dismantling. 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.		
68	Dismantling simple mechanisms such as machine vice, three jaw chucks, index head, tail stock, slotting 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.	--do--	--do--	Exercise on Orthographic views, dimensioning and sectioning 9@ 10 sheets.
69	--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--	--do--

70	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 re conditioning special tools, test mandrels, spooling gauges, bridges used in re-conditioning testing of machine after repair. Preparation of test chart.	--do--	--do--
71	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.	--do--	Projection of lines, planes and solids @3/4 sheets.
72to77	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 of Relays, auxiliary contractors, power contractors by connecting appropriate power supply. Checking of contact operation	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 in correct sequence and testing for correct functioning. Machine vice, three jaw chuck,	--do--	Practice on above portion and orthographic views. Theory of isometric projection. Preparation of isometric scale,

	<p>(opening and closing) of relays and contractors. Developing control circuit using ladder/schematic diagrams. Use of control elements to build 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>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 a 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 & 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 inter locks, Speed control of AC induction & DC motors. 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.</p>		<p>angles, arcs and circles in isometric. Construction of sphere and irregular curves in isometric.</p>
--	--	---	--	---

78	Visit to related Industrial Establishments or Revision & Test	Visit to related Industrial Establishments or Revision & Test	Visit to related Industrial Establishments or Revision & Test	Visit to related Industrial Establishments or Revision & Test
79to86	<p>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). 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.</p>	<p>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. 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.</p>	--do--	<p>Exercise on isometric Drawings and oblique projections. (@ 2 sheet each). Introduction to primary auxiliary projection. Practice on primary auxiliary projection for different solids.(@ 2 sheets). Practice on Primary Auxiliary projection, reverse auxiliary and revolution. Introduction to surface development of</p>

				<p>various solids, surface development of cube, prisms and cylinders. Surface development of cut prisms and cylinders. Surface development of Pyramids and cut pyramids.</p>
87to88	<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</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 & working principles of valves, types of valves directional control, pressure control, flow control. Direction control valves according to their spool position e.g. $\frac{3}{4}$ Dc, $\frac{2}{3}$ 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</p>	<p>Brazing lubricants & coolants. Cutting speed and feed.</p>	<p>Surface development of cones and cut cones and other exercises. (@ 2, sheets).</p>

	<p>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 pressure, float, flow switches, suction strainer, return line & 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>working principles of flow control valves and their uses. Meter in circuit, meter out circuit, bleeding off circuits. 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.</p> <p>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, 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 commissioning. Air venting and cavitations. Regular care of</p>		
--	--	--	--	--

89.	-do-	<p>hydraulics.</p> <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. 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. Selection of lubricant.</p>	-do-	--do--
90	<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>	--do--	<p>Concept of co-ordinate axis in CNC, axis designation. X,Y,Z,A,B,C & U,V,W. Application of coordinate axis in CNC</p>

91& 92	<p>History of computer(first generation to fifth generation), classification of computers, characteristics of computer block diagram, representation of characters in computers.</p> <p>Demonstration and explanation of different input, out put devices.</p> <p>Study of computer memories-Ramom Access Memory, Read only Memory ,Erasable Programmable Read Only, Memory, Floppy ,hard disk etc.</p> <p>Study of central processing unit, structure of instructions, study of communication techniques between processor, input and output.</p> <p>Study of disk operating system, basic DOS commands (e.g. DIR,MD,CD,RD,COPY,FORMAT,DEL etc.) and practicing them. Introduction to different software packages such as WordStar, Lotus, DBase, Windows. Application of these software packages. Practicing simple commands such as create/open a file, close a file, saving of files etc.</p> <p>Explain use of computer as a CNC work station, communication between CNC & computer communication hardware, software.</p>	<p>Background application, block diagram ,input devices, out put devices, CPU.</p> <p>Memory-RAM,ROM,PPROM,EPRM.</p> <p>Basic DOS commands, use of computer as CNC work station, communication between CNC & computer</p>	--do--	-do-
93 to 94	<p>Introduction to CNC technology.</p> <p>Study of special constructional and operational features with reference to driving mechanism, machine tool design, lubrication system.</p> <p>Familiarization with co-ordinate system, use</p>	<p>Introduction to CNC machines.</p> <p>Difference between NC,CNC and GPM</p> <p>Importance of CNC machines over other mass production processes.</p> <p>Constructional details & working principles of</p>	--do--	Surface development of sphere by zone method and lune method.

	<p>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> <p>i)Flexibility, efficiency, repeatability.</p> <p>ii)Axis movement-rapid, feed, jog, manual data input modes, over travel limits .</p> <p>iii)Axis driving elements-Servomotors, gear box, ball screw, position feed back, open loop, close loop control, following error, position loop.</p> <p>iv)Reference point, referencing procedure.</p> <p>v)Execution of part programme without tool(DRY RUN),plotting/tracing of job profile on paper by executing part programme for two axes interpolation for 5 to 6 different components.</p>	<p>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.</p> <p>Manual part programming.</p>		
95	<p>Study and practice of various CNC operating elements on CNC vertical machining centre.</p> <p>CNC operation-referencing (zeroing), part programming execution of part programmes.</p> <p>Use of M/S/T/G codes, and tool offsets, zero offset. Cutter radius compensation facilities.</p> <p>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> <p>1)True running of spindle assembly</p> <p>2)To withstand for radial and axial load.</p> <p>3)Types of spindle bearing-anti-friction, hydrodynamics, hydrostatics.</p> <p>4)Pre-loading of spindle bearing.</p> <p>5)Temperature rise test of spindle for proper preloading, lubrication of spindle. Lube. oil cooler.</p> <p>6)Study of gear box and automatic speed range for constant power & constant torque.</p>	<p>Pascal's law, Bernoulli's theorem-their applications</p> <p>Gears-various types, terminology</p> <p>Of gear teeth, simple and compound gearing</p>	<p>Interpenetrating Curves of solids, Lines of intersection of plain surface to plain surface , @2 sheets).</p> <p>Lines of intersection of plain surface to curved surface</p>

		<p>7)Maintenance of same as mentioned above.</p> <p>8)Spindle orientation, de-clamping of tool from spindle head.</p> <p>9) Coolant through spindle and rotary joints.</p> <p>10)Coolant and chip disposal systems.</p> <p>11)Study of tool holding, de-clamping de-vices, is-scraping, air purging, tool cleaning.</p>		@ 2 sheets). Lines of intersection of curved surface to curves surface)@ 2 sheets).
96	<p>Introduction to CNC machine maintenance, use of maintenance card, history card & recording the data.</p> <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>Linear axis feed system:-</p> <ol style="list-style-type: none"> 1) Study of 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, LM & turcite guide ways friction, anti-friction, hydrostatics & centralized lubrication systems. 	--do—	--do—
97	<p>Study of :-</p> <p>Spindle speed system :-</p> <ol style="list-style-type: none"> 1. True running of spindle assembly with radial & axial load. 2. Types of spindle bearing – antifriction, hydrodynamics, hydrostatics. 3. Pre-loading of spindle bearing . 4. Temperature rise test of lubrication of spindle. Lube oil, cooler. 	<p>Study of :-</p> <ol style="list-style-type: none"> 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 –clamping by 	--do--	--do--

98	<p>5. Study of gear box and automatic speed range for constant power and constant torque.</p> <p>6. Maintenance of same as mentioned above.</p> <p>7. Spindle orientation, de-clamping of tool from spindle head.</p> <p>8. Coolant through spindle and rotary joints.</p> <p>9. Coolants & chip disposal systems.</p> <p>10. Study of tool holding, de-clamping device, de-spring , air purging, tool cleaning</p> <p>Study of :- Linear axis feed system :-</p> <ol style="list-style-type: none"> 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. 	<p>disc, springs and de-clamping by hydraulics or pneumatic.</p> <ol style="list-style-type: none"> 5. Drive to rotary table-using servomotor or hydrometer. 6. Mounting of rotary encoder & linear optical scale on the axis. 7. Worm & Worm Wheel to eliminate backlash. 8. Turret on CNC lathes, automatic tool changer, 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. <p>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.</p>	--do--	<p>Blue print reading conventions. Welding Symbols, surface roughness Symbols and their application . Tolerance of forms and positions and their applications (@ 4 sheets)</p>
----	--	--	--------	--

99	<p>Study of “-</p> <ol style="list-style-type: none"> 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 – clamping by disc, springs and de-clamping by hydraulic or pneumatic. 5. Drive to rotary table- using servomotor or hydro motor. 6. Mounting of rotary encoder & linear optical scale on the axis. 7. Worm & Worm Wheel to eliminate backlash. 8. Turret on CNC lathes, automatic tool change, spindle orientation . 9. Hydraulic chuck tail stock, quill. 10. Accuracy & performed of CNC m/cs. Problem and remedies. 11. Inaccuracies such as backlash, repeatability. 12. Counter balancing mechanism. 	<p>Study of :-</p> <ol style="list-style-type: none"> 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-
100	<p>Hydraulic & Pneumatic power source and circuits.</p> <p>Study of different hydraulic & pneumatic circuits of CNC Turning, Milling, Grinding m/cs.</p> <p>Study of hydraulic oil, air, coolant filtration system and hydraulic accessories.</p>	-do-	--do-	<p>Exercise on solid geometry, ortho views, Development Intersection and auxiliary views (@ ¾ sheets)</p>

101 to 103	Study of :- 1. Electrical /electronic for a CNC m/c 2. CNC system hardware. 3. Feed and spindle drives. 4. Feed back devices. 5. Programmable logic controller. 6. Machine power supply. Safety interlocks.	-do-	-do-	Introduction to CAD/CAM and drawing simple component drawing on CAD (@ 2 components) Free hand sketching of o/s micrometer, Vernier & trade related tools.
104	Revision &Test	Revision &Test	Revision &Test	Revision &Test

SOCIAL STUDIES

The syllabus has already been approved and is same for all the trades.

LIST OF TOOLS AND EQUIPMENT(For a Batch of 16 Trainees)

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Steel rule 300 mm graduated both side in Metric and English	IS:1481-1970	17 nos.
2	Inside spring caliper 150 mm	IS:4052-1967	17 nos.
3	Outside spring caliper 150 mm	IS:4052-1967	17 nos.
4	Spring divider 150 mm	IS:4083-1967	17 nos.
5	Hermophrodite caliper 150 mm		17 nos.
6	Try square 150 mm	IS:2103-1962	17 nos.
7	Hack saw frame adjustable 300 mm	IS:5169-1969	17 nos.
8	Hammer Ball Peen with handle 200 gms.	IS:841-1963	17 nos.
9	Hammer Ball Peen with handle 400 gms.	IS:841-1963	17 nos.
10	Cold chisel 20 x 200 mm	IS:402-1964	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	IS:7177-1974	17 nos.
15	Prick punch 100 mm		17 nos.
16	File flat bastard 300 mm	IS:1931-1972	17 nos.
17	File flat 2 nd 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	IS:3650-1973	17 nos.
22	File half round 2 nd cut 250 mm	IS:1931-1972	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.	IS:3152-1965	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	IS:844-1962	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.

TOOLS AND INSTRUMENT FOR MAINTENANCE SHOP

Sl. No.	Name of the Tools & Equipment	IS: Code Number	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	Hammer soft (faced 30 mm dia. Plastic tipped)		2 nos.
6	Pipe wrench 45 mm		1 no.
7	Chain pipe wrench 65 m		1 no.
8	Self alignment roller ball bearing	IS:4025-1967	1 no.
9	Telescopic gauges 13 mm to 300 mm		1 set
10	Lubricant trolley 2400 x 1200 x 1200 mm (8 chamber)		1 no.
11	Cellepsable tool kit 5 compartments		1 no.
12	Tap extractor		1 no.
13	Gear pump		1 no.
14	Vane pump fixed and variable delivery		1 each
15	Piston pump (radial and axial)		1 each
16	Linear actuator (differential and non-differential)		1 each
17	Hydrameter		1 no.

18	Accumulator (spring and gas)		1 no.
19	Pneumatic tools (portable nut spanner/runner, chisel, grinder, sander and hammer.		1 each
20	Hydraulic, pneumatic trainer with necessary aggregates for different machine circuit with all type of transparent valves and pressure gauge, reservoir etc.		1 each trainer
21	Hydraulic valves (relief, sequence, unloading, pressure reducing, check, flow control, directional control valves etc.).		1 each
22	Transparent hydraulic cylinder		1 no.
23	Transparent gear pump		1 no.
24	Transparent vane pump		1 no.
25	Cut model of pneumatic valve		1 no.
26	Vibrometer		1 no.
27	Flow detector(magnetic crack detector)		1 no.
28	Machine tool calibrator		1 no.
29	Lathe tool dynamometer		1 no.
30	Engg. Stethoscope		1 no.
31	Stud extractor		1 no.
32	Tool picker collet type		1 no.
33	Tool picker magnet type		1 no.
34	Magnifying glass 75 mm	IS:5148-1965	2 nos.
35	Pin spanner set		1 set
36	Hand key way broacher		1 no.
37	Granite surface plate 1600 x 1000 with stand and cover.		1 no.
38	CI surface plate 400 x 400 mm with wooden stand and cover	IS:2285-1063	1 no.
39	Solenoid valve		1 no.
40	Pneumatic meter		1 no.
41	Head lamp		1 no.
42	Bearing and gear tester		1 no.
43	Pneumatic scraper with adjustable stroke		1 no.
44	Hydraulic wheel and bearing puller		1 no.
45	Master test bars (different size)		1 set
46	Level bottle (sprit) 150 ml.		1 no.
47	Three cell torch		1 no.

48	Gasket hollow punches 5, 6, 8, 10, 12, 19, 25 mm dia.		1 each
49	Bar type torque wrench		1 no.
50	Cam lock type screw driver		1 no.
51	Flaring tool		1 no.
52	Tube expander up to 62 mm		1 set
53	Circlip pliers (inside and outside and straight)		1 set
54	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
55	Sledge hammer 5 kgs.		1 no.
56	Viscometer		1 no.

PRECISION INSTRUMENT

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Vernier height gauge 500 mm	IS:2921-1964	1 no.
2	Vernier bevel protractor with 150 mm blade	IS:4239-1970	1 no.
3	Vernier caliper A 200 with inside and depth measurement	IS:3651-1974	1 no.
4	Direct reading vernier caliper B 300 (direct reading with dial)	IS:3651-1974	1 no.
5	Optical bevel protractor		1 no.
6	Outside micrometer 0 to 25 mm	IS:2967-1964	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 m scale , center head, sq. head and protractor head		1 no.
11	Sine bar 200 mm	IS:5359-1969	1 no.
12	Slip gauge metric set (for the whole institute)	IS:2984-1966	1 set (box)
13	Internal micrometer 5 to 30 mm	IS:2966-1964	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)	IS:2092-1962	1 no.
17	Feeler gauge	IS:3179-1976	1 no.
18	Radius gauge (metric)	IS:5273-1969	1 no.

19	Screw pitch gauge for metric pitches (0.25 to 6 mm)	IS:4211-1967	1 no.
20	Center gauge 55 degree to 47 ½ degree		1 no.
21	Centre gauge 60 degree		1 no.
22	Plug gauge, plain	IS:2251-1965&3484-1966	1 no.
23	Ring gauge Morse taper No. 1, 2, 3, 4	IS:1715-1963	1 set
24	Ring gauge 5 to 25 by 2.5 mm (Go and No Go)	IS:2251-1965	1 set
25	Limit plug gauges 5 to 25 mm by 2.5 mm	IS:2251-1965	1 set
26	Wire gauge	IS:1137-1950	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	IS:2220-1962	1 set
30	Adjustable micrometer spirit level to measure flatness, indication and taper with prismatic measuring base	IS:2220-1962	1 no.

MACHINIST TOOLS

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Cylindrical milling cutter B 63 x 90	IS:1831-1961	1 no.
2	Side and face milling cutter B 160 x 10	IS:6308-1971	1 no.
3	Side and face milling cutter B 160 x 10 (inserted type)		1 no.
4	Slot milling cutter B 10 x 6	IS:6352-1971	1 no.
5	Equal angle cutter 45 ⁰ /100	IS:6326-1971	1 no.
6	Equal angle cutter 60 ⁰ /100	IS:6326-1971	1 no.
7	Single angle cutter B 63 x 18 x 45 ⁰ (L.H.) and (R.H.)	IS:6324-1971	1 each
8	Single angle cutter B 63 x 18 x 60 ⁰ (L.H.) and (R.H.)	IS:6324-1971	1 each
9	Slot drill (Key seating) 3,4,5,6,8,12 mm parallel shank	IS:5031-1969	1 set
10	Slitting saw B 80 x 3		1 no.
11	Slitting saw B 100 x 4		1 no.
12	T-slot cutter to suit T headed bolt of 10, 12 mm S.S.	IS:2668-1964	1 each
13	Convex milling cutter 4,10, 20 mm	IS:6322-1971	1 each
14	Concave milling cutter 4,10, 20 mm	IS:6322-1971	1 each
15	Corner rounding milling cutter 2.5, 4, 10, 16 mm	IS:6314-1971	1 each
16	Woodruff key seating cutters A 13.5 x 3, A 16 x 4, A 9.5 x 5, A 19.5 x 6		1 each

17	End mill cutter SS 3, 6, 10, 12, 18, 22 mm		1 each
18	Milling gear cutter (involutes) 1, 2, 2.5, 3 module set of 8 cutter		1 set
19	Fly cutter holder		1 no.
20	Engineers parallel	IS:4241-1967	1 set
21	Scribing block universal 300 mm		4 nos.
22	V-block 100/7-80-A	IS:2949-1964	1 pair
23	Straight edge (steel) 1000 mm	IS:2022-1962	1 no.
24	Sprit level 2 V 250.05	IS:5706	1 no.
25	Spanner D.E.G.P. series 2	IS:2028-1968	1 set
26	Table chuck 3 jaw with tightening arrangement and graduated in degrees		1 no.
27	Machine vice 200 mm swivel base		1 no.
28	Machine vice swivel base 160 mm		1 no.
29	Angle plate size 4 with slots	IS:2554-1963	1 no.
30	Angle plate adjustable 250 x 150 x 175 mm		1 no.
31	Twist drill 3 to 13 mm (SS)	IS:5701-1969	1 set
32	Twist drill 13 to 25 mm by 1 mm (T.S)		1 set
33	Grinding wheel dresser (diamond) 1.5 carret		1 set
34	C-Clamp 150 mm and 200 mm		1 set
35	Hand reamer 6 to 25 mm by 1 mm	IS:1836-1961	1 set
36	Punch letter set 4 mm		1 set
37	Punch number set 4 mm		1 set
38	Mandrel 120 mm long different sizes		1 no.
39	Wheel balancing stand with its accessories		1 set
40	Pin punch 3 to 10 mm by 1 mm		1 set
41	Deep cutting hack saw frame 300 mm		2 nos.
42	Machine reamer 6 to 25 mm by 1 mm		1 set

MASONARY

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

LATHE TOOLS

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Drill chuck 30 mm		1 no.
2	Reduction sleeve and extension sockets		1 each
3	Centre drill 1 to 5 mm	IS:664-1963	1 set
4	Revolving centers with Arbor		1 no.
5	Knurling tool with holder (straight, cross and diamond)	IS:6335-1971	1 set
6	Lathe carriers up to 75 mm		1 set
7	Oil stone 150 x 50 x 25 mm		1 no.
8	Oil cane pressure feed 500 mm		1 no.
9	Boring tool holder (Armstrong) LH 8 and 10 sq. bit size x length 200 mm		1 no.
10	Tool holder 8 and 10 sq. bit size straight x length 200 mm		1 no.

GENERAL MACHINE

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
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 magnet chuck 250 x 120 mm and necessary accessories.		1 no.
5	Cylindrical universal grinding machine		1 no.
6	Drilling machine pillar 20 mm capacity		1 no.
7	Bench grinder 250 mm dia. (lighter type)		1 no.
8	Flexible hand grinder 100 mm dia. (lighter type)		1 no.
9	Portable drilling machine 6 mm capacity		1 no.
10	Tensile and Brinell hardness testing machine		1 no.
11	CNC Trainer		1 no.
12	Shaping machine 450 mm stroke (motorized) with all attachments		1 no.
13	Pipe bending machine (hydraulic)		1 no.

MACHINE FOR REPAIR AND RECONDITIONING

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Old center lathe		1 no.
2	Old milling machine (universal)		1 no.
3	Old grinding machine (universal)		1 no.
4	Old shaping machine		1 no.
5	Old press (power)		1 no.
6	Old turret and capstan		1 no.
7	Universal indexing head		1 no.

8	Revolving center		1 no.
9	Tail stock		2 nos.
10	Gear box (old)		2 nos.

WELDING WORK (GAS WELDING)

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
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.

(ARC WELDING)

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	DC welding generator 150-300 amps. Complete to AC induction with all accessories		1 no.

FOR HEAT TREATMENT

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
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.

SHEET METAL WORK

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
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.

HOISTING EQUIPMENT

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
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.

ERECTION TOOLS AND EQUIPMENT

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
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.

FURNITURE

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
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.

ELECTRICAL TECHNOLOGY AND ELECTRONICS

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Screw driver electrician 150 mm		16 nos.
2	Screw driver Philips Nos. 860, 862, 862		16 nos.
3	Long nose plier 150 mm insulated		16 nos.
4	Combination plier 150 mm		16 nos.
5	Diagonal cutter 150 mm		16 nos.
6	Tweezers		16 nos.
7	Knife 100 mm		16 nos.
8	Neon tester		16 nos.
9	Scissors 150 mm		16 nos.
10	Soldering iron 25 W		16 nos.
11	Soldering iron 65 W		16 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.

SYLLABUS FOR THE TRADE OF
MECHANIC MECHATRONICS
 (Previously designed as –MECHANIC ADVANCED MACHINE TOOL MAINTENANCE)
 UNDER APPRENTICESHIP TRAINING SCHEME (ATS)
 PERIOD OF TRAINING : 3 YEARS

BASIC TRAINING : The content of syllabus under **CRAFTSMEN TRAINING SCHEME** to be followed in the first two years (Basic Training) of Apprenticeship Training Scheme.

SHOP FLOOR TRAINING – ONE YEAR (Third year)
(TRADE PRACTICAL)

SL. NO.	AREA OF TRAINING	PERIOD IN WEEKS
1	Practice of installation of machine tools – foundation, installation & testing. Insulation of machines against vibrations. Use of anti-vibration mounting pads.	8
2	Manufacturing and / or repair of worn out parts to be replaced and special tools / gadgets / fixtures etc. used in maintenance section.	6
3	Reconditioning of general purpose machines. Air compressors, pumps, etc.	8
4	Preventive maintenance	4
5	Break down maintenance	12
6	Preventive / break down maintenance work on Hydraulic / Pneumatic systems	4
7	Maintenance of CNC machines	10

	TOTAL WEEKS	52
--	--------------------	-----------

SYLLABUS FOR RELATED INSTRUCTION

A. TRADE THEORY – 3 RD. YEAR

SL. NO.	Name of the Topic
1.0	Maintenance Records
1.1	Preparation of maintenance schedules
1.2	Use of Maintenance Cards, Log Cards, History Cards and recording the data
1.3	Reference of machine manuals – how to use them
1.4	Plant Code System
1.5	Spare parts procurement
1.6	Planning spare parts manufacturing
1.7	Maintenance stock level
2.0	CNC Machine Operation & Study
2.1	Study of co-ordinate system, machine operation controls such as emergency stop, JOG, Reference Mode, Single Block Mode, manual Data Input Mode
2.2	Study of CNC alarm messages, simple part programming for testing the machine
2.3	Study of LASER INTERFEROMETER for axes calibration. Methods of deriving backlash / tool offset values
3.0	Inspection and quality control
3.1	Definition and methods
3.2	Latest trends – use of laser beam
4.0	Work Study

4.1	Method study and work measurement. Shop layout and machine layout
-----	---

SL. NO.	Name of the Topic
5.0	Engineering Materials – Non-metallic
5.1	Use of non-metallic materials – Plastic, Nylon, Teflon, Epoxy, Rubber, Foam in engineering operation
5.2	Mechanical, physical properties and machining of these materials
5.3	Application in the construction of machine tools
6.0	Industrial Automation and Robotics
6.1	Use of manipulators and robots for engineering operations
6.2	Welding and Painting robots
6.3	Robots for loading / unloading operations
7.0	Jigs and Fixtures
7.1	Definition and principles
7.2	Points to be considered while designing jigs and fixtures
7.3	Method of location, loading and unloading
7.4	Clamping types and power devices used for clamping
7.5	Tool proofing, ejection and removal
7.6	Rigidity and stability to avoid vibrations
7.7	Table fixing arrangement
7.8	Safety devices necessary while in use
7.9	Types of jigs and fixtures

SL. NO.	Name of the Topic
8.0	Testing of Machine tools
8.1	Introduction to testing of machine tools
8.2	ISI and Schleischinger Standards
8.3	Use of test charts, measuring tools used – spirit level, plum bob, bridges, straight edges, spotting gauges, dial indicators, auto-collimator, optical flat, etc.
8.4	Care and maintenance of measuring tools.
8.5	Testing of machine tools like lathe, milling, shaping, drilling machine as per ISI specification for new and reconditioned machine tools by test mandrels and dial indicator.
9.0	Drilling Machines
9.1	Types, sizes and specification of drilling machines
9.2	Special features of radial drilling, precision drilling, multiple spindle drilling and automatic drilling machines
9.3	Study of speed and feed changing mechanisms of these machines
9.4	Care and maintenance
10.0	Boring Machines
10.1	Types- Horizontal, Vertical and Jig Boring Machines
10.2	Work holding devices and tool mounting methods
10.3	Mechanisms and operation
10.4	Care and maintenance
11.0	Slotting Machines

11.1	Types, specifications and functions
11.2	Study of driving mechanism
11.3	Variable speed reversible drive mechanism
11.4	Hydraulic drive mechanism
11.5	Study of slotter operation
11.6	Care and maintenance

SL. NO.	Name of the Topic
12.0	Planning Machines
12.1	Types, specification and use
12.2	Table drive mechanism – open and cross belt drive, reversible motor drive and hydraulic drive
12.3	Planner feed mechanism by friction disc and electrical drive
12.4	Work holding and standard clamping devices
12.5	Difference between shaper and planner – operation and mechanism
12.6	Care and maintenance
13.0	Non-conventional Machine Tools
13.1	Constructional features, principles of operation, application of spark erosion, wire EDM, copying / tracing, Laser cutting machines in an engineering industry. Study of Ultrasonic and Chemical machining processes.
14.0	Air Compressors
14.1	Compressed air production. Rotary and reciprocating type compressors. Use of coolers.
14.2	Pressure control – use of safety valves and Governors
14.3	Purification of air. Use of filter units
14.4	Care and maintenance

B. WORKSHOP SCIENCE & CALCULATION - 3RD YEAR

SL. NO.	Name of the Topic
1.	Moment of Inertia – parallel axis & perpendicular axis, theory of moment of inertia of symmetrical figures & common bodies
2.	S.H.M. – simple and compound pendulum
3.	Motion of connected bodies
4.	Bending of beam, shear stress and bending moment
5.	Torsion, equation of shaft subjected to torsion. Springs – different types, deflections.
6.	Transmission of power by rope drive, chain drive, belt drive and gear drive.
7.	Non-conventional machines – EDM, EDG, ECM, ECG, CHM, USM, AJM, LBM, EPM
8.	Material handling – lifting machines, hoist, crane conveyor, etc.
9.	Vibration – free, forced and damped type, resonance.
10.	Mounting of machines, grouting of machines, levelling, use of anti-vibration pad, balancing of machines.

C. ENGINEERING DRAWING 3RD YEAR

SL. NO.	Name of the Topic
1.	Dimensioning of tapered components. Dimensioning of key ways. Tolerance dimensioning.
2.	Types of riveted joints (Lap & Butt), types of rivet heads.
3.	Forms and ends of set screws.
4.	Types of nuts with their standard proportion
5.	Types of bolts and bolt heads

6.	Various types of locking arrangements for nuts
7.	Various types of foundation bolts
8.	Various types of keys with standard proportion.
9.	Cotter and cotter joint (socket & spigot)
10.	Cotter joint with sleeve and strap joints with jib and cotters
11.	Pin or knuckle joint
12.	Pipe joints, socket and spigot joint
13.	Hydraulic joints, CI flanged joint
14.	Types of pulleys, flat belt, V-belt, rope pulleys
15.	Various types of shaft couplings – flanged, cone, muff, universal, etc.
16.	Metric screw threads
17.	Different types of “V” and square threads
18.	Free hand sketching of Outside Micrometer, Vernier Caliper.
19.	Hydraulic, Pneumatic symbols and circuit
20.	Piping symbols and its application in drawing
21.	Drawing of bearings – bushed, pedestal, footsteps, plumber block, ball and roller bearing
22.	Introduction to Jigs and Fixtures and different elements of jigs & fixtures. Locking devices, clamping devices, types of simple drilling jigs. Foundation drawing of machine tools, e.g. lathe, drilling, milling machines, etc. (@ 6 sheets).
23.	Layout drawing for installation of machine equipment, lubrication system and coolant system
24.	Free hand sketching of gauges – snap & ring
25.	Gear technology
26.	Spur gearing
27.	Helical gearing

SL. NO.	Name of the Topic
28.	Bevel gearing
29.	Worm & worm gearing
30.	Introduction to cams
30.1	Various types of Cams
31.	Free hand sketching practice of hand tools and trade related tools
32.	Blue print reading and study of missing dimensions, machining symbols, missing limit size, fit and tolerance, etc.
33.	Practice on concept of co-ordinate axis in CNC. Exercise on system of dimensioning for CAD. (@ 2 sheets)
34.	Practice on missing lines and missing views
35.	Practice on CAD / CAM. Preparation of component drawing on CAD (@ 2 sheets)
36.	Practice on Orthographic Projection and sectional views with dimensions, roughness symbols and geometrical tolerances (@ 4 sheets)
37.	Revision and solving of old NCVT papers

