

Syllabus For the trade of
OPERATOR ADVANCED MACHINE TOOL
Under CTS AND ATS

(DESIGNED IN 2000)

Government of India
Ministry of Labour (D.G.E.&T.)
CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE
EN – Block, Sector – V, Salt Lake,
Kolkata-700091.

General Information

1. Name of the Trade : Operator Advanced Machine Tool
(Under C.T.S. & A.T.S.)
2. N.C.O. Code No. : 835.10
835.15
835.25
835.30
835.40
835.45
835.90
3. Entry Qualification : Passed 10 + 2 with Physics,
Chemistry & Mathematics or its
equivalent.
4. Duration a) Craftsman Training : 2 Years
 b) Apprenticeship Training : 3 Years including 2 Years basic
training
5. Rebate : 2 Years for ITI passed trainees in
the trade of “Operator Advanced Machine Tool”
6. Ratio to Apprentice to workers : 1:7

**LIST OF MEMBERS OF THE TRADE COMMITTEE MEETING FOR THE TRADE OF
“OPERATOR ADVANCED MACHINE TOOL” UNDER CTS/ATS HELD ON JUNE 14,2000.**

1.	Shri S.R.Majumdar	Director, CSTARI, Kolkata-91	Chairman
2.	Shri S.V.Gokhale	TELCO, Pune	Member
3.	Shri H.Bhattacharjee	TTC/CLW/Chittaranjan	Member
4.	Shri P.Nayak	Supervisor Trg. Centre Kancharapara	Member
5.	Shri A.Goswami	STC/Kancharapara	Member
6.	Shri B.C.De	C&W workshop, Liluah, E.Rly.	Member
7.	Shri A.K.Majumdar	C&W workshop, Liluah, E.Rly.	Member
8.	Shri M.K.saha	G.R.S.E. Ltd. Kolkata	Member
9.	Shri A.S.Giri	TISCO Ltd., Jamshedpur	Member
10.	Shri B.K.Vinayagam	TISCO Ltd., Jamshedpur	Member
11.	Shri M.S.Saha	ITI Purulia (WB)	Member
12.	Shri R.M.Sinha	JDT, CSTARI, Kolkata-91	Member
13.	Shri A.K.Pal	DDT, RDAT, (ER) Kolkata-64	Member
14.	Shri M.K.Majumdar	ATI, Dasnagar, Howrah-5	Member
15.	Shri S.K.Das	ADT, CSTARI, Kolkata-91	Member
16.	Shri M.B.Kerketta	T.O., CSTARI, Kolkata-91	Member
17.	Shri H.Das	T.O., CSTARI, Kolkata-91	Member

SYLLABUS FOR THE TRADE OF “OPERATOR ADVANCE MACHINE TOOL”
UNDER CRAFTSMENSHIP TRAINING SCHEME

DURATION : 2 YEARS

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
1	<u>INTRODUCTION</u> Importance of the trade training, types of the work done by the trainee & role of Operator Advanced Machine Tool in an industry. Safety equipments & their uses. Importance of cleanliness & Orderliness at the work place and house keeping. Issue of tool box and essential tools. First Aid practices – method of maintaining first aid box. Fire fighting equipment and their uses. (shop talk and demonstration). Familiarisation with various hand tools used in the trade. Safety equipments and their uses.	<u>INTRODUCTION</u> Familiarisation with institute, rule and regulation of the institute, the trade – its importance in the development of the country. Safety – necessity, safety rules, first aid and fire fighting and uses.	Composition & resolution of forces, Lami's theorem, condition of equilibrium.	Skill component, exercise on types of letters, lines and conventional symbols as per I.S.
2	Basic Bench Working Skills Preparation of filing. Standing posture with respect to bench vice for filing. Marking lines on the job surface for filing to the marked lines. Gripping the job suitably in the vice jaws for filing. Balancing of file, using rough file. Measurement by using inside/outside calipers and scale.	Basic Bench Working Skills Vice – purpose, types, description, size, construction method to use and maintenance. File – purpose, types, description, size and method to use. Use of file card, printing of file, convexity of file and proper filing technique. Rule – purpose, types, description and	--do--	--do--

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	<p>Use of simple measuring instruments such as steel rule, Vernier caliper, Inside/Outside Micrometer. Care and precaution to be observed in handling these instruments.</p> <p>Exercises on measurement of various geometrical shapes.</p> <p>Exercise on marking out according to simple blue prints, using steel rule, scriber, marking blocks & divider.</p> <p>Scribing lines on chalked or coloured (blue) surfaces of the work piece properly supported against the angle plate on marking – off table on an accuracy of + or – 0.5 mm.</p> <p>Marking location of the position of holes & scribing circles using dividers.</p> <p>Use of Dot and Center Punch for punching the lines, centers and circles.</p>	<p>method to use.</p> <p>Divider – purpose, types, description and method to use.</p> <p>Scriber – purpose, types, description and method to use.</p> <p>Marking Block – purpose, types, description and method to use.</p> <p>Punch – purpose, types, description and method to use.</p> <p>Micrometer – purpose, types, construction, calculation of least count, method to use and read, care and maintenance.</p> <p>Vernier Caliper – purpose, construction, calculation of vernier constant, method to use & read, care and maintenance.</p>		
3 & 4	<p>Balancing of file, using rough file.</p> <p>Exercise of filing flanges of a channel for balancing of file. Filing flat surface and flange of a channel maintaining parallelism between them using outside caliper within + or – 0.5mm.</p>	--do--	Friction – static and dynamic friction, laws of friction.	Construction of scales. Practice of size and location, dimension for parts, holes, angles, taper, threads etc. as per I.S.
5	<p>Exercises on filing to develop control and feel layout the dimensional features of the work piece using vernier height gauge, engineering square, angle plate and surface plate. Exercise on filing the adjoining sides</p>	<p>Vernier height gauge – purpose, types, construction, method to use and read, care and maintenance.</p> <p>Engineer's square – purpose, description and method to use.</p>	Centre of gravity and centroids of various figures and bodies.	--do--

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	<p>Square to each other and one reference surface.</p> <p>Filing faces for maintaining flatness, square-ness of adjacent side using try-square, parallelism between opposite sides and reducing thickness.</p> <p>Filing with second cut file to prepare smooth surfaces.</p> <p>Exercise on filing for maintaining dimensions within + or – 0.1mm using vernier caliper.</p>	<p>Surface Plate – purpose, description, method to use, care and maintenance.</p> <p>Angle Plate – purpose, description and method to use.</p>		
6	<p>Marking of profiles – combination of straight lines, circles, arcs and angles using scale, divider height gauge, protractor, combination set etc.</p> <p>Marking geometrical profiles on sheet metal and filing to mark lines. Sharpening of marking tools, use of bench grinder for sharpening of scriber, centre punch, dot punch, divider etc.</p> <p>Marking on the job piece for saw cuts.</p> <p>Gripping the job suitably in the vice jaws for hack sawing to dimensions.</p> <p>Hack sawing various metallic pieces (mild steel, aluminum, copper, brass, stainless steel etc.) of different thickness and cross sections, within + or - 0.5mm using hack saw blades of different pitches. Hack sawing different lengths with hack saw frame in horizontal & vertical positions</p>	<p>Combination set – purpose, description and method to use. Vernier bevel protractor – purpose, description, calculation of vernier constant, method to read and use, care and maintenance.</p> <p>Bench Grinder – purpose, description, procedure and precautions to be observed during grinding of marking tools, chisels and drill bits.</p> <p>Hack saw – purpose, types, description, method to use and precautions to be taken during hack sawing.</p> <p>Hack saw blade – purpose, types, description, select ON/OFF appropriate grade, fixing of blade and precautions to be observed.</p>	--do--	Geometrical constructions.

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	Sawing along the parallel marked lines within 0.5mm allowance for filing. Hack sawing and filing steps and slots and open fitting of finished pieces. Cutting of sheet metal with chisel.			
7	Hammering practice on vertical hold round job. Blind hammering practice. Stamping letters and numbers on M.S. plates. Exercise on stamping to develop judgment, control on hand and feel. Stamping practice on flat and round surfaces using flat, cross cut and round nose chisels for chipping edges and square to the faces and edges. Checking with Try-square, use of cross peen hammer for stretching of metal strip.	Hammer – purpose, types, description, method to use and precautions to be observed. Bending of solid selections using fixtures. Letters and Numbers – purpose, description, method to use and precautions to be observed. Hollow Punch – purpose, description, method to use for preparations of gaskets and other packing materials. Pipe Fitting – material and types of pipes used in the trade. Method to cut, to thread and preparation of pipes for ‘T’ fitting elbow fitting, reducers etc. using unions. Method to fill ferrule.	Moment of inertia, parallel axis and perpendicular axis theorem of moment of inertia of symmetrical figures and common bodies.	--do--
8	Preparation for drilling, marking out the position of holes and dot punching. Deepening the points with centre punch. Checking for centre distance. Drilling practice on sensitive drilling machine using different types of drills and drill holding devices. Safety to be observed while working on drilling machine. Marking, chain drilling and filing to produce square, round and triangular openings on 6mm thick plate. Preparing inserts and fitting in these openings.	Drills – purpose, types, description, drill holding devices, method to use a drill with or without drill chuck and precaution to be observed. Reamer – purpose, types, description, method to use, reaming allowance, coolant used and precautions to be observed during reaming. Sensitive Drilling Machine – purpose, types, description, drilling fixtures, method to drill and precautions to be observed during drilling. Procedure to be followed for counter sinking, counter boring, spot facing	--do--	Geometrical constructions.

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
		and reaming using bench drilling machine. Screw Threads – elements and forms screw threads single and multi-start thread, right and left hand thread. Taps and Tapping – purpose, types, description, precaution to be observed and method to use hand and machine taps during tapping. Types of coolant to be used. Calculation to drill size for tapping. Method to tap a blind hole, reasons for breakage of tap and method to remove broken tap. Construction and method to use tap wrench. Die and dieing purpose, types, description and method to use and precaution to be observed. Description of die stock, procedure and precautions to be observed during dieing.		
9	Drilling practice on varying thickness and different materials such as M.S., C.I., S.S., Cu, Brass, Nylon, Epoxy etc. Drilling on sheet metal, precautions and safety to be observed. Counter Sinking, counter boring, and spot facing operations using bench drilling machine. Exercise on reaming with hand reamers and machine reamers. Internal threading by hand using tap sets. External threading by split die and finishing of thread by die nut. Marking centre of a round bar with the help of ‘V’ block and clamp. Drilling and reaming of blind holes along the axis of round jobs.	--do--	S.H.M. simple and compound pendulum motion of connected bodies.	Tracing of curves.

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	Grinding of drills to specifications and checking of angles with gauges. Grinding of chisels.			
10	Measurement of shaft and hole diameters using outside and inside micrometer. Filing round out of square bar within + or – 0.1mm. Filing to an accuracy of + or – 0.1mm., checking with an outside micrometer. Preparation of plates for a gauge fitting. Exercise on filing radius and angular filing using templates and gauges. Filing templates and gauges for checking lathe tool angles. Exercise on step and angular gauge fitting.	Defining and explanation of the elements of interchangeable system basis size, limits, tolerance, allowances. System of limits, fit and tolerances types of fit. Hole basis and shaft basis. Newal, British, I.S.I./B.S.I. systems, examples of fixing limit for various types of fit commonly met within the machine.	--do--	--do--
11	Filing of various angle & clearances of lathe tool on square blanks. Checking with templates & gauge already prepared. 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. Cold riveting. Marking out location of holes for riveting. Use of dolly and snap for forming rivet heads. Lap and butt joint by cold riveting.	Gauges & Template-purpose, types, description and method to use dial test indicator. Limit gauges - purpose, types, construction and method to use limit gauges.	Stress, strain, Hook's law, elastic limit, ultimate strength, modules of rigidity, Poisson's ratio, temperature stress, resilience, elasticity, ductility, malleability, plasticity, brittleness, toughness,	Isometric and Oblique drawings for simple machine parts & casting blocks with dimensions.

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			hardness, creeping, Creep stress, fatigue stress, impact stress. Practical calculation of weight, force, pressure and cutting forces.	
12	Simple project work. Marking parallel clamp, 'C' clamp or micrometer stand using acquired skills.	Sheet metal work-purpose, types, description and method to use snip & stake. Description and method to use hand shear. Rivets & riveting-types & description of rivets. Method of lap & butt joint using dolly and snap. Cold & hot working of strips & pipes-method of bending solid sections, using fixtures for different physical conditions. Use of cutters for pipes & method to bend in hot and cold condition using fixtures.	--do--	--do--
13&14	<u>BASIC MAINTENANCE SKILLS</u> Using hand tools such as screw driver, single end/double end spanners, box nut spanners, ratchet spanners, circle pliers, wrenches, pullers, extractors, drift. Correct method to be used and care to be taken in using those tools.	<u>BASIC MAINTENANCE SKILLS</u> Screw drivers – purpose, types, description and method to use screw drivers. Spanners – purpose, types, description and method to use box, socket, tubular, hook spanner etc. Wrenches – purpose, types, description and method to use T-socket, monkey, ratchet, pipe wrenches etc. Purpose, description, precautions to be observed and method to use drift, pullers and extractors.	--do--	--do--

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
15to18	<p><u>BASIC MACHINE SKILLS TURNING</u></p> <p>Practice on functional relationship of various parts of the lathe machine. Familiarisation with the gearbox and drivers used on the machine. Methods of holding work piece and tool using different devices. Exercises on plain, stepped, taper and form turning, knurling etc. Exercises on drilling, reaming, boring, counter boring etc. Screw thread cutting both internal and external of different types. Exercise on eccentric turning. Grinding of lathe tools. Care and maintenance of machines. Safety precautions to be observed while handling machines. Lubrication of different parts and preventive maintenance. Simple projects such as hollow punch, pulleys, gear blanks, simple coupling etc.</p>	<p><u>TURNING</u></p> <p>Types, construction features working principles, functions, use accessories and attachments of lathe machine.</p> <p>Driving mechanism – cone pulley, all geared headstock, quick-change gearbox and apron mechanism. Types, materials and angles of the lathe cutting tools. Purpose and method to perform various lathe operations. Using accessories and attachments. Determination and use of cutting speed, feed and coolants, lubrication system and maintenance of lathe machine.</p>	--do--	Drawing of given models in 1 st &3 rd angle projection.
19&20	<p><u>SHAPING</u></p> <p>Functional relationship of various parts of the shaping machines. Use of quick return mechanism. Different work and tool holding devices. Flat and angular shaping. Groove cutting on shaping machine. Grinding of shaping tools. Care and maintenance of machine. Safety precaution in handling machine. Lubrication of different parts and preventive maintenance. Shaping of T-slots. Shaping keyway on a</p>	<p><u>SHAPING</u></p> <p>Constructional features, working principles, function and uses of shaping machine. Working Principle – use of quick return mechanism. Procedure to set length and position of stroke, holding of work and tools in shaping machines. Description of various tools used in the machines and procedure to perform various operations in shaping machine. Maintenance, detection of common faults and rectification.</p>	--do--	--do--

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	gear. Shaping dovetails. Machining of irregular castings.			
21to25	<u>MILLING</u> Functional relationship of various parts of the milling machines. Familiarisation with gear box and drive used on the machine. Practice on different work and tool holding devices. Exercises on parallel and angular milling. Exercises on grooving using and mills. Cutting of spur gear and helical using simple indexing. Use of slotting attachment for cutting key ways. Care and maintenance of machine. Safety precautions in handling machine. Lubrication of different parts and preventive maintenance. Simple project such as jaw, claw, Oldham, coupling, spline cutting etc.	<u>MILLING</u> Construction features, working principles, types, functions, use, accessories and attachment of milling machine. Different method of holding work piece and cutters. Procedure to perform various milling operations, such as plain, step, angular milling, slot and groove cutting. Gear element – definitions, symbols, explanation and calculations. Procedure to cut various types of gear using appropriate speed, feed and coolant for different materials. Method to detect common fault, defects and their rectification. Preventive maintenance of milling machine.	Bending of beam, shear stress and bending moment.	Conversion of isometric/oblique drawings into orthographic projections and vice-versa on machine parts.
26	<u>Revision & Test</u>	<u>Revision</u>	<u>Revision</u>	<u>Revision</u>
27&28	<u>GRINDING</u> Functional relationship of various parts of the grinding machines. Use of drive – both mechanical and hydraulic. Practice on different work holding devices. Grinding wheel specifications, mounting, balancing, turning and dressing of grinding wheels. Exercises on external and internal cylindrical grinding – both plain and taper. Simple tool and cutter grinding practice.	Constructional features, working principle, types, functions and use of surface and cylindrical grinding machine. Grinding wheels and their specifications – grit, grain, size, structure, bond, grades etc. Procedure to use grinding wheels for balancing and turning. Method to hold work and dress grind wheel. Method to perform various grinding operation selecting proper speed,	Typical cases.	Drawing of simple machine parts in 3 rd Angle Projection.

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	Care and maintenance of machine. Safety precautions to be observed while using machine. Lubrication of different parts and preventive maintenance.	Feed and coolant. Method to detect common faults, their rectification and preventive maintenance of grinding machine. Study of hydraulic system used on the machine.		
29	<p><u>ALLIED MACHINING SKILLS</u></p> <p>* PLANNING</p> <ol style="list-style-type: none"> 1. Use and operations of planning machine. Setting of work on the machine. Setting of tools in the tool holder. 2. Planning of flat surfaces – horizontal, vertical and angular. 3. Planning of open and blind key ways, T-slots, curves etc. 4. Planning dovetailed male and female parts. <p>* SLOTTING</p> <ol style="list-style-type: none"> 1. Uses and operations of slotting machine. Setting of jobs on the table and setting of tool. 2. Slotting a rectangular shape, hexagonal shape internal & external. 3. Practice of slotting key ways on a pulley. 4. Slotting irregular shape jobs having curved surfaces. 5. Slotting concave & convex surfaces. 	<p><u>ALLIED MACHINING SKILLS</u></p> <p><u>PLANNING MACHINES</u></p> <p>Types, specifications and use. Table drive mechanism. Planner feed mechanism by friction disc and electrical drive. Work holding and standard clamping devices. Difference between shaper and planner – operation and mechanism. Care and maintenance.</p> <p><u>SLOTTING MACHINES</u></p> <p>Types, specifications and functions. Study of driving mechanism. Variable speed reversible drive mechanism. Hydraulic drive mechanism. Study of slotter operation. Care and maintenance.</p>	<p>Torsion, equation for shaft subject to torsion, spring, different types and deflections.</p> <p>--do--</p>	<p>--do--</p> <p>Exercises on different sectional views on the given models/actual objects, exercises on true shape of different sectional solids.</p>

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	<p>* BORING</p> <ol style="list-style-type: none"> 1. Boring a casting job in vertical milling machine. 2. Boring on angular surfaces (use of boring tool holder). 3. Use of jig boring machine. Boring parallel and angular & holes by using rotary table. <p>* OPTIONAL OPERATION</p>	<p><u>BORING MACHINES</u></p> <p>Types – horizontal, vertical, jig boring machines. Work holding devices and tool mounting methods. Mechanisms and operation. Care and maintenance.</p>	<p>Transmission of power.</p>	<p>--do--</p>
30to36	<p><u>ADVANCED MACHINE SKILLS TURNING</u></p> <ol style="list-style-type: none"> 1. Taper turning by taper attachment. Taper turning by a form tool. 2. Internal and external taper matching and form matching. 3. Eccentric turning practice. 4. Boring and stepped boring, position boring(using button boring method). 5. Screw thread cutting of various thread forms. Fitting of male and female threaded components. Multiple thread cutting-2start. 6. Turning and boring practice on cast iron block. 7. Carbide tip brazing on shank. 8. Tool grinding practice. Grinding of carbide tools and use of negative rake tool on non-ferrous metals. 9. Relieving and profile turning. 	<p><u>ADVANCED MACHINE SKILLS TURNING</u></p> <p>Procedure to cut taper by taper turning attachment and form tool. Care to be taken for boring, step boring and taper boring in a blind hole. Procedure for cutting various internal and external screw threads. Care to be taken during internal threading in a blind hole. Procedure and care to be taken eccentric turning. Method of brazing a carbide tip on a shank. Procedure to grind a tipped tool. Procedure, care and coolant to be used during turning and boring cast iron components.</p>	<p>Belt drive, jockey pulley, rope drive, chain drive, gear drive. Machining time, feed and speed calculation and thread cutting calculations.</p>	<p>--do--</p>

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
37to50	<u>MILLING</u> <ol style="list-style-type: none"> 1. Gang milling – milling jobs of different shapes and dimensions by using gang-milling process. 2. Milling gears by differential indexing. 3. Milling hexagonal holes on a plate by attachment. 4. Milling splines (external). 5. Helical milling – milling helical group in a vertical machine. Milling a slab mill cutter. 6. Milling helical gears. 7. Milling bevel gears. 8. Milling a rack. 9. Cutting worm and worm wheel on a milling. 10. Graduation of a steel rule on a milling. 11. Milling a drum cam, plate cam. 	<u>MILLING</u> <p>Procedures for milling helical groove a slab mill cutter in vertical milling machine. Care to be taken during milling. Procedure for milling helical gears, bevel gears, rack, worm and worm wheel, drum cam and plate cam. Precautions to be observed. Method of graduation of a steel rule by milling.</p>	<p>Gears – various types. Terminology of gear teeth basic circle, pitch circle, PCD, module, addendum, dedendum, gear train, simple and compound. Gear cutting calculations.</p>	<p>Exercises on development of surfaces of simple objects like parallelepiped, cube, cone, pyramid, cylinder, prism etc.</p>
51	<u>INSPECTION</u> <p>Familiarization with inspection and master gauge checking of finished product with limit gauges for their accuracy and usability. Use of Sine Bar, snip gauges along with standard balls and rollers for measurement of taper. Measuring with tool maker's microscope. Testing of gears for its measurements and accuracy. Use of profile projector.</p>	<u>INSPECTION</u> <p>Definition, description and use of worker's inspection and master gauge. Principle, construction and use of sine bar and sine center. Types and description of slip gauges, purpose, construction and method to use tool maker's. Microscope and profile projector.</p>	--do--	<p>Exercises on interpenetration of solids.</p>

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
52	REVISION & TEST INDUSTRIAL VISIT	REVISION & TEST INDUSTRIAL VISIT	REVISION & TEST INDUSTRIAL VISIT	REVISION & TEST INDUSTRIAL VISIT
53to59	<p>OVERHAULING AND PREVENTIVE MAINTENANCE</p> <p>Familiarization with plain/journal bearings, anti-friction bearings used on machine assembly. Specification and selection for appropriate use. Use of manufacturers catalogues. Mounting of bearings on shafts and in housing with proper fit and axis alignment. Use of proper tools. Removal of bearings from shafts and housing by using pullers. Cleaning up and removing old metal from bearings and replacing with new metal and fit bearings to shaft. Fitting shaft to main line bearings. Cut oil grooves in bearings. Checking of shaft for alignment with dial indicator. Practice in scraping flat bearing surfaces.</p> <p>OVERHAULING OF SIMPLE MACHINES & ACCESSORIES</p> <p>Dismantling simple mechanism 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 and oiling of dismantled parts. Assembly and testing for</p>	<p>OVERHAULING AND PREVENTIVE MAINTENANCE</p> <p>Purpose, types, description, material, properties and application of bearings for various machines. Specification of bearings. Dimensional relationship of the shaft with bearing and the types of load. Method of mounting and dismounting of bearing on shaft and in housing and checking for correct alignment. Essential of ordinary type brass bearings and process of fitting. Commercial specification of ball, roller and anti friction bearings. Lubrication of bearings. Care and maintenance and inspection of bearings. Method of dismantling, cleaning, oiling, assembling and testing for correct functioning of machine vice, three jaw chuck, index head, tail stock, slotting attachment and coolant pumps using various hand tools with specific reference to the functional part. Sequence of operation, marking of parts and cleaning materials to be used. Method of dismantling, cleaning, oiling, assembling and testing for correct functioning of bench grinder, pedestal grinding, sensitive</p>	<p>Balancing of machines.</p> <p>Vibration free, damped forced type, resonance.</p>	<p>Drawings on screwed fastenings – screw threads, nuts, bolts, studs and other blocking devices. Drawing on keyed joints, cotter joint, pin joint and knuckle joint.</p>

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	<p>operation. Dismantling for simple machines such as bench grinder, pedestal grinder, sensitive drilling machines. Cleaning and oiling of machine parts and assembly and testing.</p> <p>PREVENTIVE MAINTENANCE</p> <p>Measure important accuracies involved in lathe, milling, grinding and shaping machine with special attention to transmission mechanism. Machine testing and capability testing, their function and operation. Use of lifting tackles e.g. chain pulley, magnetic chucks, lifting magnet, testing and safety aspects in handling.</p>	<p>drilling machine. Precautions to be taken and planning for scheduled overhauling. Procedure to level, align, test and prepare test report using spirit level, camel back, straight edge, bridge, parallel blocks, test mandrels, master cylinder, slip gauge, dial test indicator, special surface plate, marking table, lathe machines, milling machines, shaping machines, grinding machines etc. Methods of grounding of lathe, milling, shaping and grinding machines. Concepts, importance, methods and tool used for maintenance and preventive maintenance of machines. Inspection, diagnosing and repairing procedure. Scheduling and planning for preventive maintenance work.</p>		
60to64	<p>ELECTRICAL TECHNOLOGY</p> <p>Exercises on Ohm's law, Kirrchoff's law, Net work theorem, work, power, energy, series parallel circuit, measuring instruments, alternating current. Fundamental testing of switches, push buttons, limit switches, micro switches, by using continuity tester for their operation. Use of safety elements such as miniature circuit breaker (MCB), over load relay, earth leakage circuit breaker, protecting fuses in power circuit wiring.</p>	<p>ELECTRICAL TECHNOLOGY</p> <p>Safety – safety rules (I.E. Act & Rules) to be followed in connection with electrical work. First Aid when effected be electric shock. Purpose, types, description and use of common electrical hand tools. Familiarization with electrical symbols being used in electrical circuit diagram. Reading of electrical circuit/connection diagram from instructional manual. Electron theory – matter, molecule, atom, solar system, free electron, electric current and effects of electric current. Definition and properties of conductors. Insulators and semi-conductor.</p>	<p>Properties to be considered in section of materials – strength, rigidity, resistance to fatigue, damping capacity, resistance, hardness, corrosion resistance, cast iron, malleable iron, wrought iron, cast steel, brass, bronze, aluminium, rubber, plastic fibre</p>	<p>Drawings on various types of rivets and riveted joints. Drawing of various types shaft couplings, flanged, cone, universal and muff.</p>

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	<p>SINGLE PHASE, THREE PHASE SUPPLY Identification of line, neutral and earthing wires, test lamp and multimeter for identification of single phase 2 wire, 3 wire supply, three phase 3 wire and 4 wire supply, phase sequence. Single phase and three phase rectifiers, ripple, half wave, full wave rectifiers.</p> <p>THREE PHASE INDUCTION MOTOR General principle, construction, equation of the motor back e.m.f. torque characteristics. Types of the motor – shunt series, compound etc.</p> <p>ELECTRICAL LOGIC CONTROL Use of relay, contactor, timer, simple motor control, inching control, forward/reverse control by push buttons, micro switches, limit switches and pressure switches and star/delta control, manual starter, semi-automatic control, automatic control, over load relays, safety interlocks for machine operation. Logic building using relay, contactor for simple control.</p> <p>SPEED CONTROL OF 3 PHASE AC INDUCTION MOTORS Speed control by change in voltage, frequency and poles, speed control by variable frequency, variable voltage inverters. Constant torque, constant voltage</p>	<p>Classification of wires and cables. Solder, flux soldering iron, preparation of wire and cable and soldering technique for various joints of wires and cables. Classification and application of plugs, sockets, switch, fuse holders, cut out etc. Method to test switches using continuity tester. Definition and explanation of electro motive force, voltage, current and resistance. Definition and explanation of Ohm's law and Kirchoff's Law. Electro magnetism. Concept of a coil (electro magnetic) and capacitors – principle of working. Use of a coil in hydraulic and pneumatic solenoids. 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 volt meter, ammeter and multi-meter-principle of operations. Elements of electrical system control, power and safety elements. Automatic operation – use of control circuits-logical development of control circuit diagram using contactors and relays. Concept of ladder diagram. Speed control of 3 phase AC induction motors – method of speed control by</p>	<p>glass.</p>	

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	PWM controls. SPEED CONTROL OF DC MOTORS Speed control of DC shunt motor by flux control, armature voltage variation methods. Speed control of DC motor by thyristor.	change in voltage, frequency, poles, slip, inverters, variable voltage variable frequency controllers, constant torque, constant voltage, PWM controllers, their effects on characteristics of the motor. Speed control of DC shunt motor, flux control, armature voltage variation, merits and demerits. Torque-speed curve, thyristor control.		
65to73	ELECTRONICS TECHNOLOGY ACTIVE COMPONENTS Verify the characteristics of P-N junction. Half wave, full wave and bridge rectifiers. Capacitor input filters. Zener diode voltage regulator. Familiarize with light emitting diodes, seven segments displays. Verify the fundamental characteristics of transistor. CB, CE, CC configurations of transistor. Transistor as a switch. PRACTICE ON DIGITAL ELECTRONICS Construct and verify the truth table of AND, OR, NAND, NOR, EX OR logic gates. ELECTRONICS INSTRUMENTS 1. DIGITAL MULTIMETER: Measurement of AC- DC voltage and currents, resistance and continuity tests etc. 2. CRO: Measurements of time and	ELECTRONICS TECHNOLOGY PASSIVE COMPONENTS i) Fixed resistors: types of fixed resistors. Colour code, applications. ii) Variable resistors: Construction, types and applications. iii) Special purpose resistors: thermistors, LDR and their applications. iv) Fixed capacitors: types, specification, construct on applications. v) Inductance: electro magnetic induction, Faradays laws, self inductance, applications. vi) Transformer: construction, principle of operation and	Ferrous materials – pure iron, cast iron, steel.	Drawing of pipe joints-flanged joint, socket and spigot joint etc. Drawing of bearings bushed bearing, pedestal bearing, foot step bearing, plumber block, ball and roller bearings.

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	<p>amplitude using CRO.</p> <p>OSCILLATORS: Construct and measure the frequency of oscillators.</p> <p>MULTIVIBRATORS Astable, mono-astable and bi-astable multi-vibrators. Pulse shaping circuits. Differentiating and integrating circuit.</p> <p>POWER SUPPLIES Construct and find the voltage regulation in zener regulator, transistorized series regular with feed back, 3 pin fixed voltage regulators such as IC-78 and IC- 79 series, 3 pin variable voltage regulator such as ICLM-etc., switch mode power supply.</p> <p>FLIPFLOPS Assemble sequential circuits/memory elements.</p> <p>OPERATIONAL AMPLIFIER FUNDAMENTALS Study of op. amp. IC 741, op. amp. Circuits, such as inverting amplifier, voltage follower etc. Thyristors, silicon controlled rectifiers, triac, diac, UJT etc. Construct and find the relation in resistance network and binary ladder. Voltage comparator. Semi-conductors memories.</p> <p>RAM'S ROM'S PROGRAMMABLE LOGIC CONTROLLER Familiarise with the connection and operation of various types of PLCS.</p>	<p>applications.</p> <p>Semi – conductor theory. Intrinsic and extrinsic semi conductors. P-N junction use of a P-N junction for rectification, half wave, full wave and bridge rectifiers. P-N-P and N-P-N junction device, transistor – use of transistor as a switch. Use of transistor for amplification. Soldering technique as applied to PCB soldering DO'S and DON'Ts. Introduction to logic gates e.g. AND, OR, INVERTER, NAND, OR, EX-OR etc. Their truth table, analogy of logic gates by combination of series and parallel switches. Introduction to commonly used. Transducers in industries e.g. thermocouples, LDRs, thermistors, LVDT, strain gauge, magnetic pick up, photodiodes, photo electric relay. Digital multi-meter – purpose, description and method to use for measurement of AC and DC voltage and current , resistance, continuity test etc. Oscillators-utility of an oscillator circuit. Concept of positive and negative feed back. Conditions for generation of sustained oscillations. Types of oscillators. Multi-vibrators-astable, mono-stable and bi-stable circuits and their applications. Pulse shaping, differentiating and integrating circuits. Power supplies-draw back of zener</p>		

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	<p>AC AND DC DRIVES Servo motor speed control, change of direction of rotation, servo motor drives circuit.</p> <p>FEED BACK DEVICES Familiarise with the connection and output of various transducers such as thermocouple, strain gauge LVDT, LDR, magnetic pick up, optional sensor etc.</p>	<p>regulator. Transistorised series regulator with feed back. 3 pin fixed voltage regulators such as IC-78 and IC-79 series. 3 pin variable voltage regulator such as ICLM 317 etc. Draw backs of linear power supply. Fundamentals of switch mode power supply. Flip-flops – introduction to flip-flops a sequential circuits/memory elements. Concept of register. Operational amplifier fundamentals circuits with block diagram. Characteristics of ideal op-amp. And study of typical op-amp. IC 741. Application of op-amp. circuits such as inverting amplifier, non-inverting amplifier, voltage follower etc. Thyristors – family of devices used as solid state switches. Study of devices such as silicon controlled rectifiers. Triac, Diac, UJT etc. their applications and characteristics in power controlled circuit. Concept of digital to analog and analog to digital conversion. Semi-conductor memories: Concept of organization of computer memory. Types of semi-conductor memories and their properties.</p> <p>RAM'S AND ROM'S PROGRAMMABLE LOGIC CONTROLLER</p> <p>Basic block diagram, input/output, CPU, memory, earthing, operating voltages.</p>		

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
		<p>Programme development, ladder dia. Statement listing off-line and on-line programming. Hints on experience on PLCs, ladder, logic, statement list: off-line/on-line programming.</p> <p>AC AND DC DRIVES</p> <p>Servo-motor: Features of the servo-motor, advantages, difference between ordinary motor and servo-motor, basic blocks of the servo-controller, principle of operation, need of a servo-motor, accuracy, smooth control etc. Difference between AC and DC servo-motors, applications.</p> <p>FEED BACK DEVICES</p> <p>Need of feed back devices, principle of operation and construction of optical encoders, linear scales, resolver, inductosyn, resolution, mounting, coupling, connections, possible errors. Wiring of such devices, calibration procedure of the machine.</p>		
74to77	<p>HYDRAULICS & PNEUMATICS PIPES & PIPE FITTINGS</p> <p>Familiarisation with plastic deformation of materials. Cold and hot bending of strips. Bending of solid sections by using bending fixtures, bending discs etc. Cold and hot bending of pipes on different diameters of ferrous metal i.e. hydraulic pipes and non-ferrous metal i.e. copper tubes for</p>	<p>HYDRAULICS & PNEUMATICS INDUSTRIAL HYDRAULICS</p> <p>Industrial hydraulics – principles, advantages, disadvantages, safety and various symbols used. Constructional features, principles of operation, function and uses of various hydraulic component such as pumps, valves, actuators and power pack. Specification, properties and</p>	<p>Crystallographic structure-allotropic forms. Iron carbon diagram.</p>	<p>Drawing of carpentry joints-tenon and mortice joints, dovetail joint, table scrap joint, tusk tenon, pocket screw butt joint, casing joint. Drawing of welded</p>

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	<p>lubrication system. Pipe bending with or without filing in fine sand. Use of pipe bending fixture to maintain uniform bending radius. Precautions to avoid wringles. Pipe cutting using pipe cutter. Pipe threading and piping using various pipe fitting such as 'T' fitting, elbow fitting, reducers etc. Punching of holes in punches. Preparation of gaskets and other packing materials. Fullering practice and ferrule fittings.</p> <p>INDUSTRIAL HYDRAULICS</p> <p>Use of various hydraulic components such as pump, valves, actuators and power pack. Familiarisation with various symbols used in hydraulic circuit diagram. Identification of components from their out look and their specifications. Hydraulic circuit reading and tracing practice. Circuit drawing practice using symbols. Constructing simple hydraulic circuit for speed control both linear and rotational and testing for operation. Circuit building practice-regenerative (sequencing) circuit with speed and pressure (clamping) control. Counter balance circuits with speed control. Traverse and feed circuits. Differential control circuits. Circuits using pilot controlled check valve, pressure regulator valve, pressure relief valve etc. Practice on</p>	<p>application of hydraulic fluids and testing for operation. Procedure to draw and study hydraulic circuit. Maintenance of hydraulic devices. Constructional features, working principles and uses of pumps, positive and non-positive displacement of pumps, gear pump, vane pump, piston pump, axial piston and radial piston pumps. Constructional features and working principles of valves, types of valve-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 spools. Check valves, types of check valves-application-construction and use, pilot operator check valves. Servo valves, block diagram of servo valve, mechanical servo, electrical servo, single state spool servo, flapper type servo and jet type servo. Pressure control valve-constructional features and working principles of simple relief valve-compound relief valve 'A' type relief valve, 'R' type sequence valves-other types. Flow control valve-constructional features and working principles of flow control valves and their uses. Meter-in circuit, meter-out circuit, bleeding-of circuits. Compensating features, pressure temperature and flow. Actuators – constructional features and principles of</p>		<p>joints lap and butt. Drawing of gears-spur, helical, bevel, worm and worm wheel.</p>

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	<p>Machine tool application of the hydraulic drives for rotary, reciprocating, speed changing, clamping, un-clamping and feed motions. Trouble shooting in hydraulic device 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 system etc. Repairs and maintenance of pumps-gear, vane and radial piston. Repairs and maintenance of valves-pressure control, direction control and flow control. Adjustment of valves. Repairs and maintenance of actuators-single and double acting cylinders, hydraulic motors etc. Piping practice with metallic and hose pipes. Use of various types of pipe joints and fittings. Precautions to be taken in storage and handling of oils, pressure gauge, pressure selectors and filter units. Setting of various hydraulic elements for proper functioning. Repairs of hydraulic press and various hydraulically operated equipment. Fault finding by simulation.</p> <p>INDUSTRIAL PNEUMATICS</p> <p>Identification of components from their out look and their specifications. Pneumatic circuit reading drawing (from manuals) and circuit tracing practice. Circuit drawing</p>	<p>hydraulic actuator, hydraulic motor rotary actuators, hydraulic cylinders-types of their applications in hydraulic circuit, specifications-cylinder. Pipe and pipe work –type and selection, specification, material, bending of pipes, pipe bending fixtures and pipe bending methods. Standard fitting 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 installation of hoses and its importance. Constructional details, specification and uses of tank/reservoir, heat exchanger, heater, filter/strainer, pressure gauge, intensifier, accumulators.</p> <p>INDUSTRIAL PNEUMATICS</p> <p>Constructional features, principles of operation, functions and uses of pneumatic components such as valves and actuators. Method to draw pneumatic circuits using symbols, tracing out of circuits and testing for operation. Constructional details, specifications, application of power unit actuating unit control unit. Power unit-types of compressor-reservoirs, condensers, filters, service units. Actuating units-single/double acting cylinders, rotary actuators, sander, disc cylinder, nut runner</p>		

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	Practice using symbols for simple application. Constructing simple pneumatic circuits for linear reciprocating and rotary motion. Testing of operation. Circuit building practice-use of shuttle valves for control, circuit for speed regulation of single and double acting cylinders, time dependent control circuits etc. Use in low cost auto-motion, manipulators, materials handling equipment and pneumatic hand tools. Setting of pneumatic circuit elements for proper functioning-adjusting, cushioning of the cylinder, flow, pressure etc. Repairing of pneumatic chisels, grinders, sanders, hammers, nut-spanners etc.	etc. Control units-directional control, pressure control and flow control valves.		
78	Unit Test & Industrial Visit	Unit Test & Industrial Visit	Unit Test & Industrial Visit	Unit Test & Industrial Visit
79&80	COMPUTER FUNDAMENTALS Familiarise with computer as CNC work station, communication between CNC and computer i.e. series, parallel.	COMPUTER FUNDAMENTALS Background application, block diagram, input devices, output devices, CPU. Memory – RAM, ROM, PROM, EPROM. Basic DOS commands, use of computer as CNC workstation. Communication between CNC and computer.	Effect on alloying elements.	Drawing of basic hydraulic, electrical and electronics circuits.
81to89	CNC MACHINES-OPERATION Familiarisation with co-ordinate system, use of CNC codes and programming practice. Manufacturing of simple job on CNC trainer after programming-like	CNC MACHINES-OPERATION Introduction to CNC technology. Special constructional and operational features with reference to driving mechanism, machine tool design, lubrication systems. Efficiency	Aluminium and its alloys. Copper and its alloys. Magnetism and its	Practicing on dimensional with tolerance, machine symbols and

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	straight, grooving, concave, convex, taper and threading. Practice on block number, M, G, T, S code, tool offset zero offset, axis movement, interpolation. Maintenance-error messages, meaning, fault identification from messages, loose connection, earthing, electro magnetic interference etc. hands on experience on CNC operation, referencing (zeroing), programming, precautions while executing commands.	Flexibility, repeatability of machine axis movement, drive, gear box, ball screw, position feed back, need of position feed back, open loop, close loop control, following error, position loop, reference point, referencing procedure. CNC operation – referencing (zeroing), programming, execution of programmes, M/S/T/G codes, tool offsets, zero offset programming, precautions to be followed while executing commands.	alloys. Nickel and its alloys. Lead and its alloys. Zinc and its alloys. Tin and its alloys.	roughness. Valves as per I.S. Practicing detail and assembly drawings of simple machine components. Practicing free hand sketches on hand tools, simple machine parts and equipments.
90	INSPECTION Handling of comparators for measurement and checking of finished product for its use and usability. Inspection of machine parts with ultrasonic flow detector, x-ray, Gama-ray, laser beam.	INSPECTION Purpose, types, construction, function and method to use comparators. Latest inspection technique by ultrasonic flow detector, X-ray, Gama-ray, Laser beam.	--do--	--do--
91to98	INTRODUCTION TO CNC MACHINE MAINTENANCE <ol style="list-style-type: none"> 1. Spindle speed and linear axis feed systems. 2. Rotary axis. 3. Automatic tool and work changer. 4. Accuracy and performance of CNC machines, problems and remedies. 5. Correct method of mounting of elements like re-circulating ball screw, encoders, torsional coupling. 6. Work holding devices and counter 	CNC MACHINE MAINTENANCE Introduction to machine maintenance. Use of maintenance card, history card etc. and recording the data. Procurement of spare parts and maintenance of stock level. Care to be taken during installation of CNC machines. Maintenance schedule as per the manual of the CNC machines.	Welding – arc welding, resistance welding, spot welding, brazing, gas welding.	Exercise on blue print reading related to missing lines, views, sections and dimensions, as well as identification of surface, missing limit size, fits, tolerance, machine symbols on

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
	<p>Balance.</p> <p>7. Tool changer, pallet changer mechanism.</p> <p>8. Hydraulic, pneumatic power source and circuits.</p> <p>9. Hydraulic oil and filtration.</p> <p>10. Hydraulic accessories.</p> <p>11. Introduction to electronic maintenance.</p> <p>12. CNC system component description.</p> <p>13. CNC system hardware.</p> <p>14. Feed and spindle drives.</p> <p>15. Feed back devices.</p> <p>16. PLC and I/O devices.</p> <p>17. Machine electrical.</p> <p>18. Power supply.</p> <p>19. Board and component level trouble shooting.</p> <p>20. CNC machine capability testing, CNC machine preventive maintenance and simple trouble shooting.</p> <p>21. Safety practices, spares and standards.</p>			<p>machine components.</p> <p>Exercise on blue print reading on simple hydraulic electrical and electronic circuits with symbols.</p> <p>Drawing from broken element of a machine.</p>

Week No.	Trade Practical	Trade Theory	Workshop Science & Calculation	Engineering Drawing
99to103	ADVANCED MILLING (CNC) <ol style="list-style-type: none"> 1. Milling a spiral reamer end mill cutter, side and face cutter. 2. Milling a dog clutch, sprocket. 3. Copy milling with tracer attachment. 	ADVANCED MILLING (CNC) <p>Procedure for milling spiral reamer, end mill cutter, side and face cutter, dog clutch, sprocket in CNC machine. Tracer attachment and copy milling.</p>	<p>Cutting fluids – lubricants and coolants.</p>	<p>Drafting of simple components using Auto CAD. Different operation in CNC equipment for lettering/symboling/graphic design used in drawing office.</p>
104	Revision & Test	Revision & Test	Revision & Test	Revision & Test

List of tools & equipment for the trade of **OPERATOR ADVANCED MACHINE TOOLS** for a batch or unit of 12 Trainees

Sl. No.	Item	I.S. Code No.	Quantity
1.	Steel rule 30 cm. Graduated both in English and Metric unit.	IS : 4131-1970	12 nos.
2.	Outside spring caliper 150mm.	IS : 4052-1967	12 nos.
3.	Inside spring caliper 150mm.	IS : 4052-1967	12 nos.
4.	Hermaphrodite caliper 150mm.		12 nos.
5.	Divider spring 150mm.	IS : 4083-1967	12 nos.
6.	Center punch 100mm.	IS : 7177-1974	12 nos.
7.	Prick punch 100mm.		12 nos.
8.	Scraper A 250mm. (bearing).		12 nos.
9.	Scraper B 250mm. (triangular).		12 nos.
10.	Scraper C 250mm. (half round).		12 nos.
11.	Scriber 150 x 3mm. (one side offset).		12 nos.
12.	Hammer B.P. 200gms.		12 nos.
13.	Cold chisel 20 x 200mm.	IS : 841 – 1963	12 nos.
14.	Cross chisel 10 x 150mm	IS : 402 – 1964	12 nos.
15.	Diamond point chisels 10 x 150mm.		12 nos.
16.	Combination plier 150mm.		12 nos.
17.	Safety glasses.	IS : 3650-1973	12 nos.
18.	File flat bastard 300mm.	IS : 1179-1967	12 nos.
19.	File flat 2 nd . Cut 250mm.	IS : 1931-1962	12 nos.
20.	Cold chisel flat 25 x 200mm.	IS : 1931-1962	12 nos.
21.	Surface plate 400mm. X 400mm. Grade 1.	IS : 402 – 1964	12 nos.
22.	Table for surface plate 900mm. X 900mm. X 1200mm.	IS : 2285-1963	1 no.
23.	Marking off table 1200 x 1200 x 900mm.		1 no.
24.	Scribing block universal 300mm.		1 no.
25.	Vee block 100/7-80-A	IS : 2949-1964	12 nos.
26.	Try square 300mm.	IS : 2103-1962	12 nos.
27.	Outside spring caliper 200mm.	IS : 4052-1967	12 nos.
28.	Divider spring 200mm.	IS : 4083-1967	12 nos.
29.	Inside spring caliper 200mm.	IS : 4052-1967	12 nos.

Sl. No.	Item	I.S. Code No.	Quantity
30.	Straight edge steel 1 meter		12 nos.
31.	Straight edge steel 500mm.		12 nos.
32.	Steel tape 2 meter in case	IS : 1270	1 no.
33.	Steel rule 60 cm. Graduated both in English and Metric units	IS : 1481-1970	12 nos.
34.	Sprit level 2 V 250, 05 meter	IS : 5706	1 no.
35.	Hammer B.P. 800 gms. With handle	IS : 841 – 1963	12 nos.
36.	Screw driver, heavy duty 300mm. With handle	IS : 844 – 1962	12 nos.
37.	Hammer lead 1 kg.		12 nos.
38.	Combination set 300mm.		3 nos.
39.	Spindle blade screw driver 100mm.	IS : 844 – 1962	4 nos.
40.	Allen hexagonal keys 2.5 to 12mm.		12 sets
41.	Spanner D.E.G.P. series 2	IS : 2028-1968	12 sets of 7 pcs. Each
42.	Adjustable spanner 300mm.	IS : 6149	12 nos.
43.	Reduction sleeve Morse 1-1, 3-1, 4-1, 4-2, 5-1, 5-2, 6-1	IS : 2608-1961	12 nos. each set
44.	Angle plate adjustable 250 x 150 x 175mm.	IS : 2554-1963	12 nos.
45.	Solid parallels in pairs (different sizes) metric	IS : 4241-1967	12 pair of 12 trainees
46.	Oil cane pressure feed 500mg.		12 nos.
47.	Oil stone 150 x 50 x 25mm.		6 nos.
48.	Number drills HSS (parallel shank)		3 sets
49.	Drill (parallel)	IS : 5101-1969	3 sets
50.	Twist drills 3mm. To 13mm. (parallel shank)	IS : 5101-1969	3 sets
51.	Drill chuck 0.20 with taper shank	IS : 2243-1971	3 sets
52.	Centre drill A 1 to 5	IS : 664 – 1963	3 sets
53.	Grinding wheel dresser (diamond)		2 nos.
54.	Grinding wheel dresser (hunting tone type)		2 nos.
55.	Clamp C 100mm.		12 nos.
56.	Clamp C 200mm.		12 nos.
57.	Tap and die set in box metric pitch	IS : 1988-1962	1 set
58.	Drill HSS taper shank	IS : 5103-1963	3 sets
59.	File flat 2 nd cut 250mm.	IS : 1931-1972	12 nos.
60.	File flat smooth 200mm.	IS : 1931-1972	12 nos.

Sl. No.	Item	I.S. Code No.	Quantity
61.	File half round 2 nd cut 250mm.	IS : 1931-1972	12 nos.
62.	File triangular smooth 200mm.	-do-	12 nos.
63.	Needle file set	-do-	12 nos.
64.	File square 2 nd cut 200mm.	-do-	12 nos.
65.	Reamer 6mm. to 25mm. by 1mm.	IS : 1836-1961	2 set
66.	Reamer adjustable 10mm. to 15mm. by 75mm.		2 set
67.	Tool bits HSS 6mm. square		1 doz.
68.	Tool bits HSS 10mm. square		1 doz.
69.	Tool bits holder (Amstrong) LH		12 nos.
70.	Tool bits holder (Amstrong) RH		12 nos.
71.	Assorted tools for lathe, shaper, slotter & planner of different shapes & sizes.		8 nos. each of 12 trainees
72.	Hack saw frame adjustable 250 – 300mm. with blades	IS : 5168-1968	6 nos.
73.	Table chuck 75mm. jaw swivel base		2 nos.
74.	Machine vice 200mm. swivel base	IS : 4502-1968	4 nos.
75.	Machine vice 160mm. swivel base		2 nos.
76.	Hand vice 50mm. jaw		6 nos.
77.	Radius turning attachment		1 no.
78.	Angle turning attachment		1 no.
79.	Compound angle vice (standard sine)		3 nos.
80.	Universal sine		3 nos.
81.	Universal table angle plate		3 nos.
82.	Taper shank twist drill set 6.30 x 1.5mm. to suit radial drilling machine		1 set for 1 m/c
83.	Shaper tool holder turent type		3 nos.
84.	Basic chuck for slotter		1 no. for each m/c
85.	Shaper indexing center		1 no.
86.	Knurling tools (set of 3) straight and diamond	IS : 6336-1971	1 each for 12 trainees
87.	Plier cutting 200mm.	IS : 4378-1973	2 nos.
88.	Magnifying glass 75mm.	IS : 5148-1965	2 nos.
89.	Carbide tipped tools of different sizes & shapes (throw away tips)	IS : 2163-1963	3 sets

Sl. No.	Item	I.S. Code No.	Quantity
90.	Hand hammer 1 kg. With handle	IS:841-1968&620-1965	6 nos.
91.	Trainer's kit for hydraulics		12 nos.
	<u>Milling Cutters:</u>		
1.	Cylindrical cutter 63 x 90 bore dia.	IS : 1831-1961	12 nos.
2.	Cylindrical cutter 80 x 90 bore dia.	-do-	12 nos.
3.	Side and face cutter B 80 x 8	IS : 6308-1971	12 nos.
4.	Side and face cutter B 160 x 10	-do-	12 nos.
5.	Side and face cutter B 100 x 12	-do-	12 nos.
6.	Side and face cutter B 160 x 16	-do-	12 nos.
7.	Side and face cutter A 100 x 10	-do-	12 nos.
8.	Side and face cutter A 200 x 20	-do-	12 nos.
9.	Equal angle cutter 45 ⁰ /100	IS : 6326-1971	12 nos.
10.	Equal angle cutter 60 ⁰ /100	-do-	12 nos.
11.	Equal angle cutter 90 ⁰ /100	-do-	12 nos.
12.	Double angle unequal cutter 50 x 18 x 60 ⁰	IS : 6325-1971	12 nos.
13.	Double angle unequal cutter 63 x 18 x 60 ⁰	-do-	12 nos.
14.	Double angle unequal cutter 80 x 32 x 70 ⁰	-do-	12 nos.
15.	Double angle unequal cutter 100 x 36 x 75 ⁰	-do-	12 nos.
16.	Single angle cutter 63 x 18 x 45 ⁰ RH	IS : 6324-1971	12 nos.
17.	Single angle cutter 63 x 18 x 45 ⁰ LH	-do-	12 nos.
18.	Single angle cutter 63 x 18 x 60 ⁰ RH	-do-	12 nos.
19.	Single angle cutter 63 x 18 x 60 ⁰ LH	-do-	12 nos.
20.	Single angle cutter 63 x 28 x 70 ⁰ RH	-do-	12 nos.
21.	Single angle cutter 63 x 28 x 70 ⁰ LH	-do-	12 nos.
22.	Single angle cutter 63 x 28 x 80 ⁰ RH	IS : 6324-1971	12 nos.
23.	Single angle cutter 63 x 28 x 80 ⁰ LH	-do-	12 nos.
24.	Slot milling cutter 6 x 63 x bore	IS : 6352-2971	12 nos.
25.	Slitting saw (80 x 3 x 48A)	-do-	12 nos.
26.	Slitting saw (125 x 3 x 128A)	IS : 5031-1969	12 nos.
27.	Slitting saw (100 x 4 x 100A)	-do-	12 nos.

Sl. No.	Item	I.S. Code No.	Quantity
28.	Slitting saw (100 x 5 x 32B)	-do-	12 nos.
29.	Slitting saw (200 x 6 x 64B)	-do-	12 nos.
30.	Slot drill (key seating) 3mm.		12 nos.
31.	Slot drill (key seating) 4mm.		12 nos.
32.	Slot drill (key seating) 6mm.		12 nos.
33.	Slot drill (key seating) 8mm.		12 nos.
34.	Slot drill (key seating) 12mm.		12 nos.
35.	T-slot cutter to suit T-headed bolt of 10, 12mm. straight shank	IS : 2668-1964	12 nos.
36.	T-slot cutter to suit T-headed bolt of 12, 18, 22mm. taper shank	-do-	12 nos.
37.	Drill floating cutter No. 8 to 16	-do-	12 nos.
38.	Reamer floating cutter No. 1 to 9	-do-	12 nos.
39.	Tap floating cutter No. 1 to 8	-do-	12 nos.
40.	Milling cutters (involute) DP-8, 10, 12, 16 & 20, No. 1 to 8	-do-	12 nos.
41.	Milling cutters (involute) 1, 2, 2.5, 3 & 4	-do-	12 nos.
42.	Convex milling cutter 2.5mm, 4mm, 10mm., 20mm	IS : 6323-1971	12 nos.
43.	Concave milling cutter R-2.5mm, 4mm, and 10mm.	IS : 6329-1971	12 nos.
44.	Milling cutter R-2.5mm, 4mm, 10mm, and 16mm.		12 nos.
45.	Milling cutter force mill inserted type 100 x 40 bore		12 nos.
46.	Milling cutter force mill inserted type 150 x 50 bore		12 nos.
	<u>Measuring Instruments:</u>		
1.	Micrometer Outside 0-25mm.	IS : 2967-1964	12 nos.
2.	Micrometer Outside 25-50mm.	-do-	12 nos.
3.	Micrometer Outside 50-75mm.	-do-	12 nos.
4.	Micrometer depth gauge 0-200mm.		12 nos.
5.	Direct reading vernier caliper B 300 (direct reading with dial)	IS : 3651-1964	12 nos.
6.	Vernier height gauge 250mm.	IS : 2961-1964	6 nos.
7.	Vernier gear tooth caliper		6 nos.
8.	Vernier bevel protractor with 150mm. blade	IS : 4239-1970	12 nos.
9.	Bevel gauge 200mm		6 nos.
10.	Telescopic gauge 13mm. to 300mm.		3 set

Sl. No.	Item	I.S. Code No.	Quantity
11.	Sine Bar 200mm.	IS : 5359-1969	4 set
12.	Compound dial gauge with stand (metric)		4 set
13.	Dial test indicator with magnetic gauge type 1 grade A with magnetic base	IS : 2092-1069	6 set
14.	Centre gauge 60°		12 set
15.	Slip gauge set (normal set)	IS : 2984-1966	3 set
16.	Screw pitch a gauge for metric pitches (25-6mm.)	IS : 4211-1967	4 set
17.	Radius gauge metric set (1-6mm.)	IS : 5273-1969	4 set
18.	Limit plug gauges 5mm. to 25mm.	IS : 2251-1965	4 set
19.	Ring gauges 5mm to 25mm. by 2.5mm (Go & No Go)	-do-	4 set
20.	Taper gauge M.T. No. 1, 2, 3, 4 & 5		4 set
21.	Feeler gauge	IS : 3179-1965	4 set
22.	Planer gauge standard size		4 set
23.	Steel lockers for 12 trainees	IS : 3314-1965	1 no. each
24.	Steel chair for instructor		2 nos.
25.	Steel table for instructor		1 no.
26.	Work bench for fitters with four vices of 100mm. jaw		3 nos.
27.	Steel cup board 180 x 90 x 45cm.	IS : 1883-1966	12 nos.
28.	Steel cup board 120 x 60 x 45cm.	-do-	12 nos.
29.	Black board with easel		1 no.
30.	First Aid Box		1 no.

Sl. No.	Item	I.S. Code No.	Quantity
	<u>General Installation:</u>		
1.	Shaping machine 315mm. stroke (hydraulic) with all attachment. .	IS : 5990-1971	1 no.
2.	Lathe general purpose all geared – height of centers 150mm. to below between centers 150 supplied with 3 jaws and 4 jaws chuck, face plate, taper turning attachments and set of lathe tool.	---	3 nos.
3.	Drilling machine pillar 20mm. capacity.	IS : 6893-1973	1 no.
4.	Milling machine universal horizontal (motorized) No. 1 with all attachments such as : a) Universal head b) Vertical head c) Slotting attachment d) Rack cutting e) Attachment rotary table f) Dividing head g) Adaptors. Arbors and collets etc. for straight shank and mill from 3mm. to 30mm.	---	1 no.
5.	Milling machine vertical No. 1 (motorized) with all attachments.	IS : 6893-1973	2 nos.
6.	Surface grinding machine wheels dia. 180mm. (or near) reciprocating table, longitudinal table traverse 200mm (or near) fitted with adjustable traverse stop. Full motorized supplied with magnetic chuck 250mm. x 120mm. diamond tool holder, set of spanner, grease etc.	---	1 no.
7.	CNC milling and turner trainer (3 axis).	---	2 nos.
8.	CNC machining center vertical (5 axis).	---	2 nos.
9.	Air compressor of suitable capacity for pneumatic trainers kit.	---	1 nos.

N.B.:- All the general installations must be supplied with operation and maintenance manuals.

List of tool and equipments for basic training – electrical technology and electronics

Sl. No.	Item	Quantity
	<u>Training Kits:</u>	
1.	Screw drivers (electrician) 150	12 nos.
2.	Screw driver Phillips Nos. 860, 861 and 862	12 nos.
3.	Long nose plier 150mm. insulated	12 nos.
4.	Combination plier 150mm.	12 nos.
5.	Diagonal cutter 150mm.	12 nos.
6.	Adjustable spanner or side wrench	12 nos.
7.	Box spanner set	12 nos.
8.	Ring spanner set	12 nos.
9.	Tweezer	12 nos.
10.	Flat file 20mm.	12 nos.
11.	File triangular 150 mm.	12 nos.
12.	Hammer cross pane 75 kg. With handle	12 nos.
13.	Hammer small 250 gms.	12 nos.
14.	Knife 100mm.	12 nos.
15.	Neon tester	12 nos.
16.	Scissors 150mm.	12 nos.
17.	Soldering iron 25W	12 nos.
18.	Soldering iron 65W	12 nos.
	<u>Equipment:</u>	
1.	Multimeter 0-5k	4 nos.
2.	Ammeter 1 MA to 500mm.	2 nos.
3.	Ammeter 0-1A DC	2 nos.
4.	Voltmeter 0-300-600V-AC	2 nos.
5.	PF meter	1 no.
6.	Frequency meter	1 no.
7.	Meggar 500V	1 no.
8.	AC squirrel cage induction motor 30 with D.O.L. starter	1 no.
9.	Star Delta 30 starter	1 no.

Sl. No.	Item	Quantity
10.	C.T. single phase	2 nos.
11.	P.T. single phase	2 nos.
12.	Auto transformer 0-300V 8Amp.	2 nos.
13.	Grease gun	1 no.
14.	Bearing extractor	1 no.
15.	C.R.O. 50 MHz	1 no.
16.	Discrete component trainer	1 no.
17.	Linear I.C. trainer	1 no.
18.	Audio signal generator	2 nos.
19.	DC power supply 0-30V, Amp.	1 no.
20.	Thermocouple	1 no.
21.	Demonstration model for thyristorised DC motor drive (1 HP) set up	1 no.
22.	Demonstration model for thyristorised AC motor drive (1 HP) set up	1 no.

SYLLABUS FOR THE TRADE OF ‘OPERATOR ADVANCE MACHINE TOOL’
UNDER APPRENTICESHIP TRAINING SCHEME

Period of Training – 3 Years

Note : - The content of the syllabus for the Apprenticeship Training during the first 2 years training will be the same as that of the first 2 years course for ITI trainees in the trade of ‘Operator Advanced Machine Tool’.

A. Shop Floor Training (Practical Training) Duration – 1 Year

Practice on –

1. Drilling
2. Turning
3. Milling
4. Overhauling and preventive maintenance
5. CNC and CNCPC machines operation
6. CNC and CNCPC machine maintenance

B. Related Instruction (Trade Theory) Duration – 1 Year

1. Drilling machines
2. Non conventional machine tools
3. Jig and Fixtures
4. Inspection and Quality control
5. Non metallic engineering materials

6. Surface finishing processes
7. Lubricants and lubrication
8. Industrial automation and robotics
9. Lathe machines
10. Milling machines
11. Lifting tackles, hoist and cranes
12. Overhauling and preventive maintenance
13. CNC and CNCPC machines operation
14. CNC and CNCPC machine maintenance

C. Engineering Drawing

Cotter and cotter joints (socket and spigot)
Cotter joint with sleeve
Strap joint with Jib and cotters
Pin or Knuckle joint
Pipe joint, socket and spigot joint
Hydraulic joints, CI flanged joints
Various types of bolt heads
Metric screw threads
Details and assembly of clapper box
Details and assembly of screw jack
Surface roughness symbols and their applications
Tolerance of form and position and their applications
Introduction to jigs and fixtures and different elements of jigs and fixtures
Locating devices
Clamping devices
Types of simple drilling jigs
Foundation drawing of machine tools (e.g. lathe, milling, drilling m/c etc.)
Layout drawing for installation of machines and equipments

Drawing of lubrication and coolant system
Free hand sketching of different types of gauges, snap, ring
Details and assembly of bench vice
Gear terminology
Spur gearing
Bevel gearing
Helical gearing
Worm and Worm gearing
Introduction to Cams
Various types of cams
Free hand sketching practice of hand tools to related trades
Practice on missing views and missing lines
Practice on Orthographic Projection
Introduction to CAD and CAM practice on CAD and CAM

Final Test

D. Social Studies

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

NOTE : Involvement of instructional staff should be as under:-

- | | | |
|---|--------------------------|------------------|
| 1. Mechanical theory | <input type="checkbox"/> | Instructor 1 No. |
| 2. Mechanical practical | <input type="checkbox"/> | |
| 3. Electrical & electronics theory | <input type="checkbox"/> | Instructor 1 No. |
| 4. Electrical and electronics practical | <input type="checkbox"/> | |

