

**Syllabus**

**For the trade of**

**MACHINIST**  
**Under CTS & ATS**

**2007**

**Designed by**

**Government of India**

**Ministry of Labour (D.G.E.&T.)**

**CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE**

**EN – Block, Sector – V, Salt Lake,**

**Kolkata-700091.**

**List of the Members approved the Syllabus for the trade of "Machinist" under CTS & ATS held on 07.03.2003 at CSTARI, Salt Lake, Kolkata**

1.	Shri H.Somasundaram, Director	CSTARI, Kolkata	Chairman
2.	Shri D.Bhattacharya, Jr. Works Manager	Metal & Steel Factory, Ishapore	Member
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4.	Shri B.K.Nandi, Dy. Director, Trg. & Exam.	George Telegraph Trg. Instt. Kolkata	Member
5.	Shri Amitabh Mehra, Mechanical Instructor	Don Bosco Tech. Instt. Kolkata	Member
6.	Shri Bibhas Nag, AIO	Carriage & Wagon workshop, E.R. Rly. Liluah	Member
7.	Shri Bibhas Ch. Dey, Chief Trg. Instructor	Carriage & Wagon Workshop, E.R.Rly. Liluah	Member
8.	Shri Samir Kr. Mukhopadhyay, Sr. Supervisor	Technical Trg. Center, GRSE Ltd.	Member
9.	Shri Mohit Kr. Saha, Sr. Supervisor	Technical Trg. Center, GRSE Ltd.	Member
10.	Shri J.Basu, Engineer	Saha Institute of Nuclear Physics, Kolkata	Member
11.	Shri J.N.Gupta	Supervisor Trg. Center, S.E. Rly. Kharagpur	Member
12.	Shri A. Bhattacharjee, Assistant Director of Trg.	Directorate of Industrial Trg. Kolkata	Member
13.	Shri R.K.Chakroborty, Trg. Officer	RDAT, Kolkata	Member
14.	Shri T. Mukhopadhyay, Dy. Director of Trg.	CSTARI, Kolkata	Member
15.	Shri P.N.Yadav, Dy. Director of Trg.	CSTARI, Kolkata	Member
16.	Shri M.S.Ekambaram, Asstt. Director of Trg.	CSTARI, Kolkata	Member
17.	Shri M.B.Kerketta, Trg. Officer	CSTARI, Kolkata	Member
18.	Shri R.N.Manna	CSTARI, Kolkata	Member

**General Information**

1.	Name of the Trade	: MACHINIST
2.	N.C.O. Code No.	: 835.10
3.	Entry Qualification	: Passed 10 <sup>th</sup> Class examination under 10 + 2 system of education or its equivalent.
4.	Unit-Size	: 12 Trainees
5.	Duration of Training	: 2 Years
6.	Duration of apprenticeship Training	: 3 Years including Two year Basic Training
7.	Rebate for Ex.I.T.I. Trainees	: 2 years for ITI/ITC passed Trainees in the trade of Machinist
8.	Ratio of Apprentice to Workers	: 1:7
9.	Space required (workshop)	: 12 Sq.mt./trainee

**SYLLABUS FOR THE TRADE OF MACHINIST  
UNDER CRAFTSMANSHIP TRAINING SCHEME (CTS)**

Period of Training: 2 Years

Week No.	Practical Work	Trade Theory	Engineering Drawing	W/s. Calculation & Science
1	2 Induction Training:-Familiarization with the Industrial Training Institute importance of trades as per industrial growth and various types of machines used including general safety related to each machines. Demonstration on using fire fighting equipment.	3 Importance of House-keeping surrounding environment of shop needs and safety to be observed - personnel, machines and housekeeping. Various types of medical facilities provided and nearest hospitals.	4	5
2	Introduction to basic tools:- (i) Hand tools (ii) Fitting tools (iii) Measuring tools.	Hand tools and its importance, steel rule, Try square, chisel, surface gauge and care & maintenance, Hacksaw frame, blades.	Reading of simple drawing, Engineering drawing & its importance and instruments used in drawing.	
3	Chipping flat surfaces and grinding various angles to chisels, filing flat surface. Grooving with Hammer and chisel.	Classification and types of chisels, files & uses, vices - its constructions and uses. Hammers and its types. Related safety.	a. Making of Title blocks as per IS: 465-1988. b. Various sizes of drawing sheets. c. Various types of pencils & sharpening methods. d. Types of lines & their application as per IS:465:1988.	Simple arithmetic, Addition, subtraction Multiplication, Division of whole and partial number.  Properties of metals and their importance in trade.
4	Filing Flat surfaces, Uses of marking tools, Punch, Try square & basic measuring tools, caliper, steel rule.	Marking block, Steel rule, and calipers- different types and uses. Combination set-its components and uses.	-do-	-do-
5	Filing flat surfaces, checking with steel rule and Try square. Hack sawing.	Hacksaw blade, Hacksaw frame and its types. Drill bits- parts, Types & uses.	Use of drawing tools simple geometrical construction.	Fraction & decimals, conversion of fraction to decimals and vice-versa.
6	Marking and Drilling holes on flat pieces. Tapping as per simple drawing.	Introduction to Hand Taps & Dies and their types, applications, care and maintenance. Familiar with tap and drill size, Thread Terminology.	Geometrical construction, regular polygon circles.	Properties of C.I.& its types, uses. Properties of Non-ferrous metals and its identifications.
7	Filing Tee shape job.	Forging tools, its importance and types such as tongs, swage block, anvil etc.	Geometrical construction of polygon inscribed circles.	Properties of copper, Zinc, mild steel, aluminium etc.
8	Filing flat type polygon.	Heat treatment process Annealing, Normalising, Tempering, Hardening, case hardening and its importance. Use of vernier caliper and its parts, construction, principle & reading, use & care.	Curves and types of curves & their application and method of drawing curves.	Physical properties of Brass, Steel, bearing metals, etc.
9	Fitting male and female square piece to close limit. Application of vernier caliper in making job.	Outside micrometer, its types and construction, parts, reading use, care and maintenance.	Geometrical construction, cycloid, hyperbola, Parabola curves, Ellipse, involute curves.	Decimals, Division, Multiplication.

10	Fitting male and female square piece to close limit. Application of vernier caliper in making job.	Study about Depth gauge, micrometers and dial test indicator - their parts and construction.	Free hand sketch of lines, polygons, ellipse etc.	Logarithm and how to find out mantissa & characteristics. Properties of C.I. steel.
11	Quarterly Revision and Test	Revision and Test	Revision and Test	Revision and Test
<p><b>ACHIEVEMENTS</b> The Trainees should know and do :- Marking, chipping, filling, hack sawing. Able to understand proper application of hand tools. Able to make job within <math>\pm 0.1</math> mm Accuracy. Use of basic marking, measuring tools, Precision instruments, micrometers, Vernier Caliper. Various process of hardening, tempering etc.</p>				
12	Introduction to Shaping machine and its construction. Setting of strokes, tools, job on table machining of Rectangular block, steps, with the use of Basic tools. Safety points to be observed while working on a shaper.	Introduction of shaper, types classification, General principles of power transmission on shaping mechanism.	Free hand sketch of basic tools and simple geometrical const. Cone, pyramid, frustum, prisms, sphere etc.	Work, power, energy.
13	-do- Setting of vice, setting of block on vice checking accuracy	Shaping parts, construction use of parts, quick return mechanism ratio etc.	-do-	Motion, velocity and related problems.
14	Shaping Hexagonal, Rectangular block as per sketch checking with caliper & steel rule, angle protractor.	Various tools of shaping machine and their angles and importance of angles.	Construction of scale diagram, division of odd parts of scale with drawing instruments by sketch.	Volume, mass, density and related problems.
15	Shaping "V" blocks with slides, measurement of 'V' groove with vernier bevel protractor, measurement of slots by vernier caliper with 0.02 mm accuracy.	Various methods of holding jobs, use of clamps, nuts & bolts V- blocks, angle plates shaping operations, their importance.	Letters and its types and drawing of letters.	Properties of metals and their applications.
16	Shaping Tee slots, shaping angular surfaces, shaping concave & convex surface with use of tee slot tools, form tools.	Tool head - its parts and application, function of each part of tool head.	Methods of drawing ellipse. How to draw by drawing instruments.	Square roots, power, conversion of decimal to Fraction & vice versa.
17	1. Cutting of external keyway on shaper. 2. Shaping block.	Shaping tools and types. Speed, feed, depth of cut. Surface finish as per ISI system.	Simple dimensions with techniques and location of parts as per dimensions, angle, taper.	Square roots, power conversion of decimal to Fraction and vice versa.
18	Revision and Test.	Revision & Test.	Transforming of various measurements, linear, Angular, Circular etc.	Multiplication power root of a number. Revision and Test.
<p><b>ACHIEVEMENTS:-</b> The trainees should know and do:- 1. Machining of various operation with proper setting of speed &amp; feed. 2. Use of different types of cutting tools. 3. Machining job on shaper to an accuracy of 0.15 mm.</p>				
19	General introduction to slotting. Safety points to be observed while working on a slotter.	Slotter-principle, construction, details, driving mechanism, quick return motion and speed ratio. Safety precaution comparative study with a shaping machine. Classification of slotting machine.	Freehand sketches of trade related hand tools cutting tools, measuring tools.	Ratio and proportions, Ratio, finding forms and ratio proportions direct and indirect proportions.

20	Slotting a rectangular job checking and measuring with gauges & precision measuring instruments.	-do-	Application of ratio and proportion to shop problems.
21	Slotting a rectangular job checking & measuring with gauges and precision measuring instruments.	-do-	Mixed direct and indirect proportion problems.
22	Slotting square and hexagon internal and external. Slotting a double ended spanner.	Free hand sketches of trades related hand tools, measuring tools.	Machines-basic principles, velocity ratio, mechanical advantage, efficiency. Related simple problems.
23	Practice on slotting key ways on pulley-internal and external slotting irregular shaped jobs having curved surfaces.	Use of tool with holder for internal operations. Precautions to be observed during slotting internal operations.	Algebraic symbols & fundamental algebraic operations signs & symbols used in algebra, co-efficient, terms like terms & unlike terms.
24	-do- Slotting internal operations.	Introduction to coolant & lubricant-difference between them, types and uses of each.	Addition, subtraction, multiplication and division.
25	Slotting concave and convex surfaces.	Use of circular marks on the table for slotting curves.	Logarithm & Antilogarithm. Problems on logarithms.
26	Revision and Test	Revision and Test	-do- Problems relating to log table. Revision and Test.
<b>ACHIEVEMENTS:-</b>			
The trainees should know and do:-			
a) Operate a slotting machine.			
b) Cut slots, key ways and curves.			
c) Perform simple operations to an accuracy of $\pm 0.1$ mm.			
27	Introduction of planning machines, Adjustment of stroke, setting of tool, vice on planer table machining of rectangular block on planer. Safety points to be observed while working on a planer.	Introduction to Planning M/c. parts, types, constructions, details of Driving mechanism of planer, quick return motion etc.	Pictorial drawing. Isometric drawings of simple block.
28	Planning angular, Horizontal, vertical operations, planning Dovetail.	Tool head of planer its construction and various function of each part v- block, clamps, bolts, step block and other holding devices.	-do-
29	Planning of various key ways (open & blind). Types of operation, concave & convex surface i.e. goose neck clamp.	Cutting tools for Planer - their material and types. Templates, gauges, their fixtures and vices.	-do-
30	Planning V Block machining of planer gauge.	Hydraulic mechanism of planer their advantages, disadvantages.	Ratio & percentages and related problems.
31	Planning male & female dovetail, grinding of tools, checking with Vernier bevel protractor & roller methods.	Dovetail measurement external and internal by vernier bevel protractor.	Meaning of stress, strain, elasticity, tensile properties. -do-

32	-do-	Checking of Dovetail by roller method.	-do-	Meaning of stress, strain, elasticity, tensile properties. Stress and its important factors example. Revision and Test.
33	Revision and Test.	Revision and Test.	Revision and Test.	Revision and Test.
<b>ACHIEVEMENTS:</b>				
The Trainees should know and do :- (i) To operate of planning m/c. setting of stroke, job on planer table etc.				
34	Introduction to an engine lathe. Holding of round job in an independent chuck and truing it. Holding the tool in a tool post, centering the job with the tool. Facing & drilling.	Introduction to lathe. Its types, engine lathe construction, detail function of parts size and specification. Safety points to be observed while working on a lathe.	Standard method of sectioning as per IS-696. Exercises for different sectional views on the given orthographic drawing of machine parts, castings etc.	Simple machines like winch pulley & compound axle etc. with examples.
35	Parallel turning between centers, parting off, chamfering using roughing, finishing and parting off tools.	Lathe tools their angles & uses. Driving mechanism, speed and feed mechanism & lathe accessories.	Standard method of sectioning as per IS-696. Exercises for different sectional views on the given orthographic drawing of machine parts, castings etc.	Factors and equations of algebraic formula.
36	Holding the job in three jaw chuck truing, centering facing. Step turning undercutting, knurling drilling and boring.	Chucks-different types of job holding devices on lathe and advantages of each type. Mounting and dismounting of chucks.	-do-	Factors and equations types of factorizations.
37	Taper turning by offset method checking of the taper with precision instruments. Taper turning by swiveling compound rest, setting the compound rest to correct degree, checking the tool height, clamping the saddle for no longitudinal movement, checking up with precision instruments.	Taper introduction, types and uses. Calculations of tapers. Measurement of taper by sine bar and slip gauges.	-do-	standards and measurements equations simple simultaneous quadratic equations.  Atmospheric pressure, pressure-gauge, gauge pressure & absolute pressure.
38 & 39	Cutting V thread external and internal in a lathe. Checking up with screw pitch gauge. Cutting square thread external & internal on a lathe.	Different thread forms their related dimensions and calculations screw cutting in a lathe. Measurement of threads by three wire methods.	Inter conversion of Isometric to orthographic drawings and vice-versa. Related problems such as V blocks-simple stepped blocks, block oriented by various machining operations etc.	Application-construction and solution of problem by equations.
40	Revision and Test	Revision and Test	-do- Revision and Test	Revision and Test
<b>ACHIEVEMENTS:</b>				
Trainees should know and do:- • Operate lathe safety. • Various operations on lathe such as plain turning, step turning, undercutting, knurling taper turning, drilling and threading with an accuracy of $\pm 0.1$ mm.				
41	Introduction to milling machine, demonstration on working principle, setting of job, setting of cutter in arbor, setting of vice on table. Safety points to be observed while working on a milling machine.	Milling machine importance of milling machine, types and specification of milling machine, driving and feed mechanism of milling machine.	Interconversion of isometric, oblique drawings to orthographic drawings and vice-versa. Related problems such as V blocks, simple stepped blocks, block oriented by various machining operations etc.	Power & introduction to exponent & laws of exponent.
42	Sequence of milling six faces of a solid block. Checking the accuracy with the help of try-square scribing block and vernier height gauge.	Classification & different types of milling cutters & their use. Parts and nomenclature.	-do-	-do-

43	Step milling using side and face cutter checking with micrometer.	Vernier height gauge construction, graduations vernier setting & reading vernier bevel protractor, construction graduation setting and reading. Care and maintenance of vernier height gauge and bevel protractor.	Free hand sketch of sectional tools.	Arithmetical operations involving logarithms in the computations.
44	Straddle and gang milling operations including up-milling and down milling.	Different milling operations plain-face, angular, form, slot, gang and straddle milling etc. Up and down milling.	Interconversion of isometric, oblique drawing to orthographic drawings and vice-versa. Related problems such as V block simple stepped blocks, blocks oriented by various machining operations.	Problems related to trade using logarithm tables.
45	Milling concave and convex surfaces.	Different types of milling attachments and their uses.	Surface development of simple geometrical solids like cube, rectangular block, cone, pyramid, cylinder, prism etc.	Density of solid and liquids-related simple problems.
46	Introduction to indexing head types, setting and aligning of indexing head with reference to job on milling machine.	Indexing-introduction & types. Indexing head-constructural details, function of indexing plates and the sector arms. Calculation for various types of indexing.	-do-	Specific gravity principle of Archimedes.
47	Milling square and hexagonal job by simple indexing method.	-do-	-do-	Relation between specific gravity and density. Related simple problems.
48	Milling dovetail and T-slots both male and female matching each other. Milling Rack of straight teeth.	Gear introduction, use and type. Elements of a spur gear. Gear tooth of each forms types, merits and demerits of each. Spur gear calculations, curves and their uses.	Interpenetration of solids and conventional application of intersectional curves on drawings.	Geometry - Fundamental geometrical definitions angles and properties of angles, triangles and properties of triangles.
49	Milling of spur gear having even and odd number of teeth.	Selection of gear cutter type and form & various methods of checking gear and its parts.	Free hand sketches/drawing of gear tooth.	Pythagoras theorem, properties of similar triangles.
50	Introduction to grinding machine surface grinder, cylindrical grinder. Driving and feed mechanism, job holding devices mounting of wheels.	Grinding machine introduction types, specification, their parts and functions & uses. Safety points to be observed while working on a Grinding machine.	Solution of NCVT Test Paper (Preliminary)	Solution of NCVT Test Paper (Preliminary)
51	Wheel balancing & truing. Grinding of parallel and stepped jobs. Dressing of grinding wheels.	Types of Abrasives and their uses, Glazing and loading of wheels. Explain the importance and necessity of quality.	Revision.	Revision.
52	Revision and Test.	Revision and Test.	Test (Preliminary)	Test (Preliminary)
<b>ACHIEVEMENTS:-</b>				
The trainees should know and do:-				
<ol style="list-style-type: none"> <li>1) Operate milling machine safely.</li> <li>2) Do milling within an accuracy of <math>\pm 0.075</math> mm.</li> <li>3) Operate grinding machine safely.</li> </ol>				
53	Checking of alignment of lathe centers and their adjustments. Center drilling, step turning between centers recessing and chamfering & measurement with vernier caliper. Taper turning by taper turning attachment.	Turning of taper by taper turning attachment advantages and dis-advantages taper calculations.	Revision of 1 <sup>st</sup> Year topics.	Revision of 1 <sup>st</sup> Year topics.

54	Cutting square threads (left & right hand) on a lathe-checking with thread gauge-grinding of tool and setting in correct position.	Screw cutting on a lathe. Terms relating screw thread major/ minor diameter pitch and lead of the screw, depth of thread simple gear train and compound gear train change gears for fractional pitches.	Revision of 1 <sup>st</sup> Year topics.	Revision of 1 <sup>st</sup> Year topics.
55	1. Cutting multi-start V thread on lathe. 2. Cutting key way broaches.	Difference between single and multi-start threads-their uses merits and demerits. Broach - its types and uses.	Screw thread their standard forms as per I.S external and internal thread conventions on the features for drawings as per I.S.I.	Rectangle, square Rhombus, parallelograms etc. and their properties.
56	Cutting ACME threads (Male and female) on a lathe. Lead screw.	Square thread its form and calculation of depth, core dia, pitch dia. Acme thread its forms use and calculations.	-do-	Circle and properties of circle. Regular polygon.
57	Cutting acme threads on lathe (Male and female).	Square threads-its forms and calculations of depth, core dia, pitch dia, Acme threads-its forms, use and calculations.	Sketches for bolts, nuts, screw and other screw screwed members.	Application of geometry to shop problems.
58	Turning of irregular jobs using face plate.	Face plate- its construction safety precaution in holding jobs on face plate.	-do-	Heat & Temperature thermometric scales their conversions.
59	Exercise on use of pillar drill in drilling, counter sinking, counter boring. Spot facing and use of spot facing tools.	Pillar drill machine constructional details, functions of parts. Application of pillar drill.	Standard rivet forms as per ISI	Temperature measuring instruments.
60	Further practice of drilling of Radial drills. Practice of reaming on drilled holes.	Radial drills function parts etc. Reamer- parts, types, uses.	-do-	-do- co-efficient of expansion and related calculations.
<b>ACHIEVEMENTS:-</b>				
The trainees should know and do:-				
1. Perform turning operations.				
2. Cut square and acme thread.				
3. Perform drilling operations on pillar drill.				
4. Turn jobs according to blue print within an accuracy of $\pm 0.05$ mm.				
61	Shaping key way on gears and pulley blocks.	Special tools - use and precautions to be observed for shaping internal keyways dovetails & 'T' slots.	Riveted joints- Different types.	Quantity of specific heat of solids, liquids & gases.
62	'T' slots cutting in shaping machine.	Various material for single point cutting tools, tipped tools, their brazing and grinding process. Tool angles and their effect on cutting various materials.	Riveted joints- Different types.	Heat loss and heat gain with simple problem.
63	Cross Dovetail cutting on shaper.	Cutting speed, feed, depth of cut for slotting, shaping and time calculation.	Sketches of keys, cotter & pin joints.	Mensurations, plain figures-triangles, square, rectangles, parallelogram.
64	Shaping cross dovetails mating jobs male and female.	Checking of dovetail grooves with vernier caliper and roller. Their calculations and use of sine bar, slip gauge and dial test indicator.	Sketches of keys, cotter & pin joints.	Plain figures trapezium, regular polygons, circle hollow circles.
65	Shaping of casting jobs, using angle plate, jack and clamps. Machining of irregular shaped intricate casting.	Properties of metals general idea of physical, mechanical properties of metals, colour, weight, hardness toughness, malleability, ductility their effect on machine ability.	Sketches for simple pipe unions with simple pipe line drawings.	Plain figures segment and sector of circle, ellipse fillets.



66	Grinding of form tools and shaping of convex and concave surfaces.	Use of radius gauges and template. Introduction to jigs and fixtures. Types and uses.			Solid figures prism, cylinder, pyramid, cone.
67	Revision and Test.	Revision and Test.		Concept of assembly drawing and detailing simple assembly and their details of trade related tools/jobs/ exercises with dimensions from the given sample or model. Tool post for the lathe with screw and washer.	Solid figures- Frustum of cone sphere, spherical segment.
<b>ACHIEVEMENTS:-</b>					
The trainees should know and do:-					
1. Machine concave and convex surface on shaping machine.					
2. Shape irregular shaped intricate casting.					
3. Perform shaping operation with the accuracy of $\pm 0.05$ mm.					
68	Machine of curves on a slotting machine. Slotting of a double ended spanner.			Interchangeability - Limit, Fit, Tolerances, and allowances.	Material weight and cost problems related to trade.
69	-do-			-do-	
70	Slotting internal & external operations. Machining of internal spline and external spline on slotter uses to match each other.			Free hand sketches of V-blocks with clamps.	Trigonometry, Trigonometrical ratios use of trigonometric table.
71	Cutting external and internal spur gear on slotter use of rotary table.			Introduction and their indexing process on a slotter by its rotary table graduations. Form tool for slotting machines. Calculation for spur gear in relation to graduation of circular table.	Area of triangle by trigonometry.
72	Slotting regular & irregular job and contours and sprockets.			Calculation for cutting sprocket.	Finding height and distance by trigonometry.
<b>ACHIEVEMENTS:-</b>					
The trainees should know and do:-					
1. Cut spline, internal and external gears and sprocket on a slotter.					
2. Machine double ended spanner, regular and irregular shaped job on a slotter.					
3. Perform slotting with an accuracy of $\pm 0.10$ mm.					
73	Planning long jobs having "T" slots and dovetails grooves.			Tool setting for dovetail use of relevant tool and their grinding process. Alignment of long jobs with precision instruments.	Application of trigonometry to shop problems.
74	-do-			-do-	Triangle of forces. Parallelogram of forces.
75	Setting and planning no. of casting jobs at a time.			Hydraulic transmission in machine tool - its advantages and application hydraulic system of a planer. Use of planer gauge for setting tool and template for profile checking.	Composition and resolution of forces.
76	Marking fabricated jobs & machining on a planer.			-do-	-do-

77	Demonstration of marking system of grinding wheels. Different Tool and Cutter grinding practice on Tool & Cutter grinding m/c.	Selection procedure of grinding wheels. Abrasives its types Bonds, Grade Grit, structure, different shapes of wheels and their uses.	-do-	Representation of forces by vectors. Simple problem on lifting tackles like jib cranes, wall cranes and solution of problem with the aid of vectors.
78	Milling tongue and groove on a mating job. checking with precision instruments and gauges.	Inside micrometer, Principle, construction graduation reading both in English and metric system gauge-types and uses.	Details and assembly of bush bearing	-do-
79	Milling cylindrical cutter.	Spiral introduction, type and elements. Difference between helix & spiral. Difference between R.H. and L.H. helix.	Types of curves. How to draw. Free hand sketches of different types of cams.	-do-
80	Milling end mill/drum cam.	Spiral-lead, helix angle and calculation.	Details and assembly of simple coupling.	Simple problems on strength and crank lever.
81	Cutting reamer on milling m/c.	Reamer Calculation & off-setting	-do-	Centre of gravity simple experimental determination stable and neutral equilibrium simple explanation.
82	Milling Drill	Cam Introduction development and use.	Blue print reading simple exercises related to missing lines.	Friction co-efficient of friction.
83	Cutting face cam.	Use of proper cutting speed and feed for various metals. Calculation for the machining time, machining allowances. Lubricant/coolants and various ways of their application.	-do-	Simple problem related to friction.
84	Cutting a plate cam with angular setting	Cam-lobe, lead setting of dividing head. Calculation.	Blue print reading simple exercises related to missing views.	Magnetic substances natural and artificial magnets.
85	Boring a casting job in a vertical milling machine.	Vertical milling machine its parts, construction, method of boring in a vertical milling. Difference between horizontal and vertical milling machine.	-do-	Basic principle of electricity. Method of magnetization & uses of magnets.
86	Milling gears by differential indexing, Measuring the teeth with a vernier gear tooth caliper.	Vernier gear tooth caliper, its construction and application in checking gear tooth.	Simple exercises related to missing symbols	Basic principle of electricity.
87	Milling hexagonal hole on a plate by attachment.	Elements of milling cutter Rake angle, primary, secondary and clearance angles, lead etc.	-do-	Use of fuses, conductors switches, insulator etc.
88	Milling spline (external) Milling straight fluted Reamer.	Introduction to broaching methods of milling splines. Its calculations and selection of cutters.	Simple exercises related to missing lines.	Simple electric circuits. Simple calculations.
89	Milling a helical groove in a vertical milling machine. Milling a slab mill cutter. Milling twist drill.	Spiral milling lead, pitch, helix angle R.H. and L.H. swiveling the table in relation to the helix angle, selection of cutter for spiral milling. Calculations for spiral milling.	-do-	Ohm's law simple calculations electrical insulating materials.
90	Milling a helical groove in a vertical milling machine. Mill a slab mill cutter.	Helical gear introduction elements and calculation. Introduction geometry and uses of bevel gears.	Simple exercises to missing dimensions.	Graphs Abscissa & ordinates, graphs of straight line, related to 2 sets of varying quantities.
91	Milling helical gears. Cutting bevel gears on a milling machine by using bevel gear cutter.	Quality control types of variation, causes of variation, measurement of testing, gear & error.	Hand drawing for indicating switches, buttons controls m/c. tool excess quadrant point value.	-do-

92	Milling a rack. Milling face cam.	Introduction to rack, its use & application. Rack cutting attachment, calculation for linear pitch, circular pitch, Gear ratio, Indexing movement, etc.	Solution of NCVT Test Paper.	Further practice on logarithm. Shop problems on estimation of material, time taken for machining a job elementary time and motion study.
93	Cutting worm and worm wheel on a milling machine, gashing and finishing.	Introduction, geometry and use of worm and worm wheel.	-do-	Shop problems on estimation of material, time taken for machining a job, elementary time and energy.
94	-do-	Cam-types, application in modern m/c. tools, its special advantages, manufacturing process, calculation for milling a drum cam.	-do-	Transmission of power by belt pulley and gear drive.
95	Graduations of steel rule on milling machine. Use of tolly cutter.	Reamers, types and uses of reamer milling calculations angles of cutter, no of teeth, increment lead, gear ratio depth of cut etc. selection, setting of cutter.	-do-	-do-
96	Milling a drum cam. Milling a plate cam.	End mill cutter types and uses, calculations, angle of cutter, depth of cut, backing off etc. Advantages of helical teeth over straight teeth. Life of a milling cutter.	Revision	Solution of NCVT papers.
97 & 98	Milling a spiral reamer, milling an end mill cutter with helical teeth.	Side and face cutter types and uses. Its calculation setting of the job for cutting teeth on the face and at the side tilting of single angle cutter for giving backing.	Revision	-do-
99	Milling side and face cutter (straight teeth).	Angle form cutters calculations specifications No. of teeth, bore size, outside dia, angles etc.	-do-	Revision.
100	Milling angle form cutters.	Introduction to CNC Technology CNC M/c. principle advantages classification, drives, controls.	CNC part programming manual part programming.	Revision.
101	Simple programme and operating CNC M/c.	Basic information on CNC machine & maintenance of CNC M/c. computer aided CNC Language.	Preparation of processing instructions. Solution of CNC problems.	Revision.
102	Contouring on CNC machine.	Surface finishing necessity and different processes. Non Traditional machining process. Introduction, classification.	Solution of CNC problems.	Revision.
103	Project work on CNC machine.	-do-	-do-	-do-
104	Revision / Test.	Different processes and uses. Revision / Test.	Institute Test.	Institute Test.

**ACHIEVEMENTS:-**

The trainees should know and do:-

1. Perform gang milling and form milling operations.
2. Mill step gears, helical gear, bevel gear.
3. Mill rack, worm wheel, hexagonal hole, using a slotting attachment.
4. Graduate steel rule bore a casting in a vertical mill machine.
5. Perform milling operation up to an accuracy of  $\pm 0.05$  mm.
6. Able to perform simple programming and operations on CNC.

**FINAL ACHIEVEMENTS:-**

1. On completion of two year training, trainees will be able to operate on different machines according to Drawing.

**LIST OF TOOLS AND EQUIPMENT FOR THE TRADE OF "MACHINIST" 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 & Metric units	IS: 1481-1970	12 nos.
2.	Outside spring caliper 150 mm	IS: 4052-1967	6 nos.
3.	Inside spring caliper 150 mm	IS: 4052-1967	6 nos.
4.	Herafordite caliper 150 mm	IS: 4083-1967	6 nos.
5.	Divider spring 150 mm	IS: 7177-1974	6 nos.
6.	Centre Punch 100 mm	IS: 841-1968 & 620-1965	12 nos.
7.	Hammer B.P. 0.5 kg.	IS: 3650-1973	2 nos.
8.	Combination Plier 150 mm	IS: 1179-1967	12 nos.
9.	Safety glasses	IS: 1931-1962	12 pairs
10.	File flat bastard 300 mm	IS: 1931-1962	12 nos.
11.	File flat 2 <sup>nd</sup> cut 250 mm	IS: 1931-1962	12 nos.
12.	Engineers screw driver	IS: 844-1962	12 nos.
13.	File flat smooth 200 mm	IS: 1931-1962	12 nos.
14.	Cold chisel flat 25 x 200 mm	IS: 402-1964	12 nos.
<b>Tools, Instruments and General Shop Out fits</b>			
15.	Surface plate 400 mm x 400mm grade - I	IS: 2285-1963	1 no.
16.	Table for surface plate 900 x 900 x 1200 mm	IS:	1 no.
17.	Marking off table 1200 x 1200 x 900 mm high	IS:	1 no.
18.	Scribing block universal 300 mm	IS: 2949-1964	2 nos.
19.	V-Block 100/7 - 80 - A	IS: 2103-1962	2 nos.
20.	Try square 300 mm	IS: 4052-1967	2 nos.
21.	Outside spring caliper 200 mm	IS: 4083-1967	2 nos.
22.	Divider spring 200 mm	IS: 4052-1967	2 nos.
23.	Inside spring caliper 200 mm	IS:	2 nos.
24.	Straight edge steel 1 meter	IS: 1270	1 no.
25.	Straight edge steel 500 mm	IS: 1481-1970	1 no.
26.	Steel tape 2 meter in case	IS: 5706	1 no.
27.	Steel rule 60 cm graduated both in English & Metric units	IS: 841-1963	2 nos.
28.	Spirit level 2V 250, 05 meter	IS: 844-1962	1 no.
29.	Hammer B.P. 800 gms. With handle	IS:	12 nos.
30.	Screw driver, heavy duty 300 mm. with handle	IS: 844-1962	4 nos.
31.	Hammer lead 1 kg.	IS:	2 nos.
32.	Combination set 300 mm	IS:	1 no.
33.	Spindle blade screw driver 100 mm	IS: 844-1962	4 nos.

34.	Allen Hexagonal keys 2.5 to 12	IS:	2 sets
35.	Spanner D.E.G.P. series 2	IS:2028-1068	6 sets of 7 pieces each
36.	Adjustable spanner 300 mm	IS:6149	2 nos.
37.	Reduction sleeve Morse 1-1, 3-1, 4-1, 4-2, 5-1, 5-2, 6-1,	IS:2608-1961	2 nos.
38.	Angle plate size 200 x 100 x 200 mm	IS:2554-1963	2 nos.
39.	Solid plate adjustable 250 x 150 x 175 mm		2 nos.
40.	Angle parallels in pairs (different sizes) in Metric		12 pair
41.	Oil Can pressure feed 500 mg.	IS:4241-1967	6 nos.
42.	Oil stone 150 x 50 x 25 mm		2 nos.
43.	Number drills H.S.S. (parallel shank)		1 set
44.	Drill (parallel shank)		2 sets
45.	Twist drills 3 mm to 13 mm (parallel shank)	IS:5101-1969 to 5105-1969	1 set
46.	Drill Chuck 0.20 with taper shank	--do--	1 set
47.	Centre drill A 1 to 5	IS:2243-1971	1 no.
48.	Grinding wheel dresser (diamond)	IS:664-1963	2 sets
49.	Grinding wheel dresser hunting time type		1 no.
50.	Clamps C 100 mm		2 nos.
51.	Clamps C 200 mm		2 nos.
52.	Tap and Die set in box metric pitch		2 nos.
53.	Drill H.S.S. taper shank	IS:1988-1962	1 set
54.	File flat 2 <sup>nd</sup> cut 250 mm	IS:5103-1963	2 sets.
55.	File flat smooth 200 mm	IS:1931-1972	4 nos.
56.	File Half round 2 <sup>nd</sup> cut 250 mm	IS:1931-1972	4 nos.
57.	File triangular smooth 200 mm	--do--	4 nos.
58.	Needle file set	--do--	4 nos.
59.	File square 2 <sup>nd</sup> cut 250 mm	--do--	1 no.
60.	Reamer 6 mm to 25 mm by 1 mm	IS:1836-1961	4 nos.
61.	Reamer adjustable 10 mm to 15 mm by 75 mm		1 set
62.	Tool bits H.S.S. 6 mm square		1 set
63.	Tool bits H.S.S. 10 mm square		1 doz.
64.	Tool bits holder (Armstrong) L.H.		1 doz.
65.	Tool bits holder (Armstrong) R.H.		4 nos.
66.	Assorted tools for lathe, shaper, slotter & planner in different shapes and sizes		as required
67.	Hacksaw frame adjustable 250-300 mm with blades	IS:5168-1969	2 nos.
68.	Table chuck 75 mm jaw swivel base		1 no.
69.	Machine vice 200 mm swivel base		4 nos.
70.	Machine vice 160 mm swivel base	IS:4502-1968	2 nos.
71.	Hand vice 50 mm jaw		2 nos.
72.	Radius turning attachment		1 no.
73.	Angle turning attachment		1 no.
74.	Compound angle vice (standard sine)		1 no.
75.	Universal vice		1 no.
76.	Universal table angle plate		1 no.
77.	Taper shank twist drill set 6.30 x 1.5 mm to suit radial drilling machine		1 set
78.	Shaper tool holder turret type		1 set
79.	Base chuck for slotter		2 nos.
80.	Shaper indexing center		1 no.
81.	Knurling tools (set of 3) straight and diamond	IS:6335-1971	1 no.
82.	Plier cutting 200 mm	IS:4378-1973	1 each
			2 nos.

83. Magnifying glass 75 mm IS:5148-1965. 2 nos.  
 84. Carbide tipped tools of different sizes and shapes (throw away tips) IS:2163-1963 2 sets  
 85. Hand hammer 1 kg. With handle IS:841-1968 & 620-1965 2 nos.

**Milling Cutters**

1. Cylindrical cutter 63 x 90 bore dia. IS: 1831-1961 3 nos.
2. Cylindrical cutter 80 x 90 bore dia. IS:1831-1961 3 nos.
3. Side and face cutter dia 80 x 8 IS:6308-1971 2 nos.
4. Side and face cutter dia 160 x 10 IS:6308-1971 3 nos.
5. Side and face cutter dia 100 x 12 IS:6308-1971 2 nos.
6. Side and face cutter dia 160 x 16 IS:6308-1971 2 nos.
7. Side and face cutter dia 200 x 20 IS:6308-1971 3 nos.
8. Side and face cutter dia 100 x 10 IS:6308-1971 2 nos.
9. Equal angle cutter 45°/100 IS:6326-1971 2 nos.
10. Equal angle cutter 60°/100 IS:6326-1971 2 nos.
11. Equal angle cutter 90°/100 IS:6326-1971 2 nos.
12. Double angle unequal cutter 50 x 12 x 55° IS:6325-1971 2 nos.
13. Double angle unequal cutter 50 x 12 x 60° IS:6325-1971 2 nos.
14. Double angle unequal cutter 50 x 12 x 70° IS:6325-1971 2 nos.
15. Double angle unequal cutter 50 x 12 x 75° IS:6325-1971 1 no.
16. Single angle cutter 63 x 18 x 45° RH IS:6324-1971 1 no.
17. Single angle cutter 63 x 18 x 45° LH IS:6324-1971 1 no.
18. Single angle cutter 63 x 18 x 60° RH IS:6324-1971 1 no.
19. Single angle cutter 63 x 18 x 60° LH IS:6324-1971 1 no.

**Measuring Instruments**

1. Micrometer outside 0-25 mm IS:2967-1964 4 nos.
2. Micrometer outside 25-50 mm IS:2967-1964 2 nos.
3. Micrometer outside 50-75 mm IS:2967-1964 1 no.
4. Micrometer depth gauge 0-200 mm IS:2967-1964 1 no.
5. Digital micrometer 0-25 mm 1 no.
6. Direct reading vernier caliper 0- 300 (direct reading with dial) 1 no.
7. Digital vernier caliper 0- 300 mm 1 no.
8. Vernier height gauge 250 mm 1 no.
9. Vernier gear tooth caliper 1 no.
10. Combination set with 300 mm rule 1 no.
11. Vernier bevel protractor with 150 mm blade 2 sets
12. Bevel gauge 200 mm 1 no.
13. Telescopic gauge 13 mm to 300 mm 1 set
14. Sine Bar 200 mm 1 no.
15. Compound dial gauge with stand (metric) 1 no.
16. Dial test indicator with magnetic gauge type 1 grade A with magnetic base 1 no.
17. Center gauge 60° 1 set
18. Slip gauge set (normal set) metric (for the hole institute) 1 set
19. Screw pitch for metric pitches (25-6 mm) 2 sets
20. Radius gauge metric set (1-6 mm) 1 set
21. Limit plug gauges 5 mm to 25 mm by 2.5 mm 1 set
22. Ring gauges 5 mm to 25 mm by 2.5 mm (GO & NO GO) 1 set
23. Taper gauge M.T. No. 1, 2, 3, 4 & 5 1 set
24. Feeler gauge 1 no.

25. Planer gauge standard size

Furnitures

- |  |              |       |
|--|--------------|-------|
| 1. Steel lockers for 12 trainees                     | IS:3314-1965 | 1 no. |
| 2. Steel chair for Instructor                        |              | 1 no. |
| 3. Steel table for Instructor                        |              | 1 no. |
| 4. Work bench for Fitters with 2 vices of 100 mm jaw |              | 1 no. |
| 5. Steel cup board 180 x 90 x 45 mm                  | IS:1883-1966 | 1 no. |
| 6. Steel cup board 120 x 60 x 45 cm                  | --do--       | 1 no. |
| 7. Black board with easel                            |              | 1 no. |
| 8. First Aid Box                                     |              | 1 no. |

General Installation

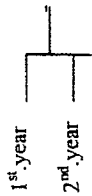
- |  |                         |        |
|--|-------------------------|--------|
| 1. Shaping machine 450 mm stroke (motorized) with all attachments  | IS:5990-1971            | 2 nos. |
| 2. Shaping machine 315 mm stroke (hydraulic) with all attachments  | IS:5990-1971,           | 1 no.  |
| 3. Double column planer 1500 x 1000 (motorized) with all attachments   | IS:4872-1968            | 1 no.  |
| 4. Slotter 180 mm stroke (motorized) with all attachments  |                         | 1 no.  |
| 5. Lathe general purposes all geared height of centers 150 mm to below<br>Between centers 150 mm supplied with 3 jaw and 4 jaw chuck, face plate,<br>Taper turning attachment, steadies etc. and set of lathe tools. | IS:2392-1963            | 3 nos. |
| 6. Tool and cutter grinder 250 mm to admit 450 mm between center-fully motorized<br>work head supplied with tool rest of different types table clamps and other attachments.   |                         | 1 no.  |
| 7. Drilling machine pillar 20 mm capacity.   |                         | 1 no.  |
| 8. Radial drill 1200 mm area motorized with tapping attachment   | IS:6893-1973 (Part-III) | 1 no.  |
| 9. Silicon carbide grinder for carbide tipped tools  |                         | 1 no.  |
| 10. Milling machine universal horizontal (motorized) No. 1 with all attachments such as:-  |                         | 1 no.  |

- |   |              |       |
|---|--------------|-------|
| a. Universal head   |              | 1 no. |
| b. Vertical head  |              | 1 no. |
| c. Slotting attachment  |              | 1 no. |
| d. Rack cutting attachment  |              | 1 no. |
| e. Rotary table   |              | 1 no. |
| f. Dividing head  |              | 1 no. |
| g. Adaptors, arbors and collects etc. for straight shank and mill from 3 mm to 30 mm  | IS:6893-1973 | 1 no. |
| 11. Milling machine universal horizontal No. zero with all attachments  | --do--       | 1 no. |
| 12. Milling machine plain type horizontal (motorized) No. 2 with all attachments  | --do--       | 1 no. |
| 13. Milling machine vertical No. 1 (motorized) with all attachments   |              | 1 no. |
| 14. Surface grinding machine wheel dia. 180 mm (or near) reciprocating table,<br>longitudinal table traverse 200 mm (or near) fitted with adjustable traverse stop.<br>Full motorized supplied with magnetic chuck 250 mm x 120 mm diamond tool<br>holder set of spanner, grease gun etc. |              | 1 no. |
| 15. Cylindrical grinder   |              | 1 no. |
| 16. CNC milling trainer with all accessories and consumables in duplicate   |              | 1 no. |

**NOTE**

1. No addition items are required to be provided to the batch working in the second shift except the items under trainees lockers.
2. Items marked @ are not required to be provided for any additional batches.
3. The specification of a number of item, in the list have been given as per I.S. Other items should also be procured according to I.S. specification, if available.
4. Training should be imparted on forging heat treatment by utilizing the existing facilities where-ever available.

**SYLLABUS FOR THE TRADE OF "MACHINIST" UNDER APPRENTICESHIP TRAINING SCHEME FOR PERIOD OF THREE YEARS**



1<sup>st</sup> year

2<sup>nd</sup> year

3<sup>rd</sup> year

During 1<sup>st</sup> year and 2<sup>nd</sup> year the apprentices will undergo the same syllabus as CTS.

In 3<sup>rd</sup> year course of training the operations prescribed for 1<sup>st</sup> year and 2<sup>nd</sup> year course of training should be repeated to brush up their skills. Actual training will depend on the existing facilities available in the establishments.

**The establishment/industries who fall in any one of categories listed below should engage the apprentice for the trade of machinist :-**

1. Establishment having the facilities like :-  
Lathe, shaping machines, slotting machines, planning machines and milling machines.
2. Establishments having the facilities like :-  
Lathe, shaping machines and milling machines.
3. Establishments having CNC setup and other non conventional machines like EDM (Electro discharge machine), wire cut machine etc. even though they do not have any machine listed in Sl. 1 above.
4. Establishments having special machines such as Gear generating machine and other machineries related to the machinist trade.

**The list of the skills to be imparted in the shop floor training for the apprentices are listed below as a reference:-**

1. Shaping blind, open key ways.
2. Shaping concave, convex, dovetail, tee slot operations.
3. Shaping irregular surfaces.
4. Shaping male female dovetails & T jobs.
5. Shaping internal spur gear.
6. Slotting spines male and female.
7. Grinding various cutting tools.
8. Slotting of irregular contour on castings and forgings.
9. Slotting both the internal and external spur gear with form tool on circular table.
10. Grinding of single point cutting tools for shaper, slotter, planner and lathe.
11. Grinding of Form Tools.
12. Cutting of all the types of threads on lathe.
13. Eccentric turning/crank shaft turning.
14. Milling spur gear.
15. Milling spur gear by compound indexing.
16. Milling spur gear by differential indexing.
17. Milling sprocket wheel.
18. Milling helical gear.
19. Milling bevel gear.
20. Milling scroll plate.
21. Milling worm and worm wheel.
22. Milling heart and drum cam.
23. Milling pivot cam.
24. Milling taper and adjustable reamer.
25. Milling twist drill.
26. Milling odd and even tooth clutch.
27. Preventive maintenance.
28. Planning 'V' and flat guide on forging and castings.
29. Planning a 'T' slot, dovetail.



30. Sharpening of various types of multipoint milling cutter.
31. Grinding of side and face cutter.
32. Hardening and tempering of single point cutting tool.
33. Grinding ring gauge.
34. Grinding Jig.
35. Gear generating by gear hobbing, gear shaping
36. Simple programming and operation on CNC machines.
37. Simple operations on non-traditional machines

### TRADE THEORY (3<sup>RD</sup> YEAR)

1. Safety of work-accidents does not happen, they are caused, protective devices and guard action taken in emergencies.
2. Revision of work of previous two years.
3. Speed changing and automatic feed mechanism of various machine tools used in trade such as shaper, grinder, slotter, planer and miller etc.
4. Brief description of boring machines and their uses of boring bars and floating tools.
5. Brief description of special machine tools used in machine shop such as precision lathe, capstan, turret, copying and relieving lathe, thread grinders, centre less grinding machines, gear shaper, gear planer, hobbing machine, thread milling machine, broaching machine, band saws, filing machine etc. and use of those machines related to this trade.
6. Machinability of materials such as mild steel, bronze, aluminium, stainless steel, cast iron, brass, bearing metals and non-metallic materials etc.
7. Importance of proper use of cutting fluids and coolants, their properties and applications.
8. Interchange ability fits, limits, tolerance and allowances.
9. Method of holding and locating work special holding devices their description and uses.
10. Precision marking, tools used in marking, their description care and uses.
11. Importance of checking or measuring the finished part using measuring instruments and gauges, their description, care and uses.
12. Use of manufacturers hand books, catalogues, tables and other data.
13. Routine maintenance of machine tools.
14. Further work on heat treatment – heat treatment of high speed steel, secondary hardening. Furnaces for hardening, high speed steel, such as muffle furnace, salt bath etc. Gas carburising, nitriding and artificial ageing and stabilising-hardness testing.
15. Hydraulic and pneumatic mechanism in machine tools related to the trade.
16. Shop Layout : Importance of shop layout in relation to production flow, principle of machine locations in respect of adequate space, lighting, safety and other conveniences etc.
17. Modern developments in the trade, new technique etc.
18. Inspection : Inspection of dovetails, gear teeth etc. reduction of scrap by stage inspection.
19. Introduction to work simplification related to the trade, job study, job analysis, including planning of sequences of operation – practical approach and method of operation. Estimation of material and time, job handling.
20. Surface finish : Importance of quality finish of jobs at all stages-surface finish terms-surface finish symbols as per ISI method of measurement of surface finish. Introduction to international system of unit. Honing, lapping and super finishing protection of finished surface etc.
21. Calculation related to the trade for cutting helical gear, worm gear, bevel gear.
22. Cam milling and its types.
23. Briefing about I.S.O. 9000 and quality management systems.
24. Cost of rework.
25. Importance of quality circles.
26. Necessity of preventive maintenance.
27. Importance of maintenance.
28. Revision and Test.

## WORKSHOP SCIENCE & CALCULATION (3<sup>rd</sup> Year)

**NOTE:** The syllabus in the subject of Workshop Science and Calculation for the first two years under A.T.S. would be identical to that of 2 years under C.T.S. and would remain unchanged.

### (A) WORKSHOP SCIENCE

1. Revision of the previous years syllabus with some practical problems related to trade.
2. Brief description of the manufacturing process of steel, copper, aluminium, cast iron and pig iron.
3. Applied problems on work-energy-power. I.H.P., B.H.P. efficiency.
4. Torque: Simple problem centripetal force and centrifugal reaction.
5. Friction: Limiting friction-laws of friction-co-efficient of friction and angle of friction on inclined plane. Simple problems sliding friction & rolling friction.
6. General condition of equilibrium of a series of forces acting on a body.
7. Examples on uniformly loaded beams.
8. Solution of NCVT test papers.
9. Revision.

### (B) WORKSHOP CALCULATION

1. Revision of previous years syllabus with practical problems related to trade.
2. Surface speed drilling, turning.
3. Calculation of machining time for drilling, turning, milling, shaping and grinding.
4. Feed, depth of cut and volume of metal removed in turning, drilling and milling.
5. Simple gear calculation – gear ratios, calculation spur gear, transmission of power by belt.
6. Solution of NCVT test papers.
7. Revision.

## ENGINEERING DRAWING (3<sup>rd</sup> year)

**NOTE:** (The syllabus on the course outline in the subject of Engineering Drawing for the first two Years training under A.T.S. training programme would be identical to the training of 2 years under C.T.S. and would remain unchanged).

1. Review and revise the first two years course contents with relation to the need of the establishment.
2. Sketches of Orthographic/Isometric/Oblique views with dimensions section and symbols for the given object/parts/components e.g. machined blocks involving with various operations, a machined blocks for bearing, housing brackets, angle plate, V-block single point tool etc.
3. Sketches of the joints of screwed members locking devices for screw threads, shafts couplings using bolts, nuts, keys, cotter joint between shaft and sleeves.
4. Standard welding symbols as per ISI and their applications on drawing of a welded fabrication.
5. Systems of the application of limits and fits, geometrical tolerance machining symbols, geometrical tolerance on drawing – simple working drawing of trade related exercises using limits, fits, tolerance machining symbols etc. e.g. simple fittings, grounds stepped shafts and blocks etc.
6. Assembly and detail drawing of trade related machine parts/tools e.g. clapper box, tail stock, bench vice, simple drill jig etc.
7. Advance blue print reading relating to missing limit size, fits, tolerance machine symbols, reading out of detail part drawing from an assembly and such other related problems from assembly drawing for operational analysis.
8. Solution of NCVT test papers.
9. Revision.

## SOCIAL STUDIES

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