

**GOVERNMENT OF INDIA
MINISTRY OF LABOUR
ADVANCED TRAINING INSTITUTE, SION, MUMBAI-400 022
SYLLABUS FOR MACHINIST (GRINDER) TRADE**

1ST

YEAR.

Week No.	Practical Work	Theory	Engineering Drawing	W/s. Calculation Science
1.	2.	3.	4.	5.
1.	Induction Training- Familiarization with the Institute Importance of trade training machinery used in the trade type of work done by trainees. In the institute, types of jobs made by the trainees in the trade. Introduction to safety including firefighting equipment and their uses etc.	Importance of safety and general precautions observed in the institute and in section. Importance of Industrial Economy of the country. What is related instructions subjects to be taught achievement to make. Recreational Medical facilities and other extra curricular activities of the institute (all necessary guidance to be provided to the new comers to become familiar with working of industrial training institute system including store procedures etc)		
2.	Identification of different hand tools and use of fitters hand tools.	Safety precautions, Description of hand tools, care and maintenance and material from which they are made. Ferrous and non-ferrous metal and their identification by different methods.	Free hand sketching of straight the rectangles, square, circles polygon etc.	Applied workshop problems involving multiplication and division common fractions, additions, subtraction, multiplications and division application fraction to solve problems.

3.	Marking chipping.	Safety precautions, description of hand tools, care and maintenance and material from which they are made.	Free hand sketching with dimension scale and proportionate sketching, Geometrical construction for marking.	Properties and use of cast iron plain carbon steel, high speed steel and alloy steel.
4.	Grinding of Chisels, Hacksawing, Measuring different types of jobs by steel rule caliper etc.	Theory of Semi precision instruments.	Reading at simple blue print.	Allied words shop problems as in week No.2
5.	Drilling, reaming, tapping and threading with dies.	Relation between drill & tap sizes, care of taps and dies and their correct use.	- do -	Properties and uses of copper zinc, lead, in aluminium, brass bronze, solder, bearing, metals timber and rubber plastic fibreglass and thermocole.
6.	Drilling different sizes of holes by hand and machine. Use of screw drivers, spanners, pliers etc. simple fitting.	Brief description of drilling machine use and care.	Sketching of view of simple solids as mentioned above when viewed perpendicular.	Brief description of manufacturing process of pig iron and cast iron.
7.	Filing practice, simple fitting.	Heat treatment of metals and its importance, various methods of heat treatment such as hardening, tempering normalising etc.	To their surfaces and axes.	
8.	Centre lathe, and parts setting of jobs and tools grinding of lathe tools of various angle of M.S.Shanks.	Brief description of a Centre lathe, its use.	- do -	Reduction of common fractions to decimal fractions, shop problems.
9.	Parallel turning, taper and turning and boring.	Lathe tools and their uses taper and its types and problems on taper.	- do -	Properties of metals physical chemical and mechanical.
10.	Cutting morse taper on lathe.	Taper turning methods and problem.	Free hand sketching of nuts bolts with dimensions from samples.	Metric system, metric weights and measurements unit conversion

				factors.
11.	Simple screw cutting (External and Internal)	Method of screw cutting simple calculation. Tap size drill size & vice versa.	Free hand sketching of rivets and washer with dimensions from samples.	Metric system, metric weights and measurement unit conversion factors.
12.	Cutting vee threads on Gear shaft.	Thread and its element types.	Free hand sketching of keys and screw threads with dimension from samples.	Shop problems on metric system of weight and measurement.
13.	Simple turning according to the print.	Various operations performed on lathe accuracy etc.	- do -	Effect of alloying elements on properties of cast iron & steel.
14.	Safety rule on shop floor maintenance and control of grinding machines oiling cleaning etc.	Introduction to Grinding trade and machine safety precautions according to IS : 1991-1962.	Explanation of simple orthographic projection 1st angle.	Square root-square of a perfect square. The square root of a whole no. and a decimal..
15.	Measurement of different types of job by steel rule, caliper etc. Taper by angular protractor.	General measuring tools (used in grinding shop) their description, use care and maintenance.	Explanation of simple orthographic projection 3rd angle.	Mass unit of mass, Force. The weight of a body. Unit of weight, shop problems.
16.	Setting wheel dresser, dressing and truing of wheels.	General dressing tools used in grinding section such as wheel, diamond dresser, steel type dresser, abrasive dress and nonferrous dresser.	View of simple hollow and solid bodies with dimensions. Use different types of lines and symbols for drawing.	Percentage and its application. Shop problems.
17.	Checking measuring various types of jobs using micrometers, vernier caliper vernier height gauge etc. Grinding practice on cylindrical grinding machine.	Precision instruments English and metric micrometer, vernier caliper, dial test indicator etc. their description and uses.	- do -	C.G.S. System of Units of force, weight etc. their conversion problems.
18.	Grinding practice on surface and cylindrical grinding machine (Grinding should be performed both on soft and	Principle and value of grinding in finishing process, various types of grinding wheels their construction	View of simple hollow and solid bodies with dimension. Use of different types of lines and	Ratio and proportion shop problems and percentages problems.

	hardened materials). Checking dimension by vernier height guage.	and characteristic glazed and loaded wheels.	symbols for drawing.	
19.	Grinding practice on surface and cylindrical grinding machine. Grinding parallel block and plain mandrel to size.	Principle and value of grinding in finishing process, various types of grinding wheels their construction and characteristic, glazed and loaded wheels.	View of simple hollow and solid bodies with diamension. Use of different types of lines and symbols for drawing.	Algebra, algebraic symbols addition, subtraction, multiplication and division of expression involving algebraic symbols. Simple aquations and transposition problems.
20.	Rough and finish grinding or surface and cylindrical job according to drawings.	Different types of abrasive manufacture of grinding wheels, their grades.	Simple isometric drawing, isometric views of simple object such as square rectangle cubes rectangular block.	- do -
21.	- do -	- do -	- do -	- do -
22.	Grinding different metals relating to suitable wheels.	Grit and different types of bonds, such as vitrified resinoid, rubber etc. Selection of suit. Different types of metals.	- do -	Standard algebraic for mula e.g. $(a + b)$ $(a-b)$ etc. simple simultaneous equations with two unknown quantities.
23.	Selection of grinding wheels for grinding different metals, selection of suitable wheel to obtain rough and IS: 1249-1958.	Factors effecting selection of wheels, identification of wheel, marking of system of grinding wheels IS : 551-1966.	Simple isometric drawings, isometric views of simple objects such as square, rectangle cube, rectangular block etc.	Simple algebraic problems.
24.	Externals and internal grinding operation, changing the wheel speedet, obtain recommended wheel and controlling depth.	Grinding wheel speed, surface speed per minute conversion of peripheral speed to r.p.m. Depth of cut and range at usefulness.	Use of drawing instruments "T" square and drawing board.	Mensuration area of rectangles, squares, triangles circles, regular polygon etc. Calculation of areas.
25.	Grinding sockets	Depth micrometer	Construction of	Simple algebraic

	morse taper and checking depth by depth guage micrometer.	and vernier caliper.	simple figures and solids as mentioned above with dimension and titles. Use of different types of scales in inches and millimeters.	problems.
26.	Grinding External sleeve.	Common types of surface grinding machine, plain surface, rotary surface, horizontal and vertical surface grinder etc. Method of grinding tapers.	- do -	Calculation on volume and weight of simple solid bodies such as cubes square and hexagonal prism shop problems.
27.	Machine setting for automatic movements and parallel grinding on cylindrical grinder.	Common types of grinding machines. Plain cylindrical external and internal cylindrical grinder and universal grinder.	Lettering nos. and alphabets.	Heat and temperature thermometric scale. Farrenheit and centrigrade scales and their conversion. Name and use of temperature measuring instruments normally used in workshop.
28.	Testing and mounting wheels selves, truing and rebalancing and grinding parrel mandrel.	Test for alignment and checking, balancing at wheel, dressing different types of wheel, dressers, their description and uses.	Free hand isometric sketching of simple objects with dimension.	Shop problems on determination of volume and weight of simple solid bodies.
29.	Wheel balance and dressing grind no long bar, using steady rest.	Test for alignment and checking, balancing of wheel, dressing different types of wheel, dressers their description and uses.	- do -	Heat treatment hardening and annealoug.
30.	Grinding different types of jobs using machine chuck, face angle plate collets.	Holding devices such as Magnetic chuck, chucks and face plates collets their description and	Free hand isometric sketching of simple objects with dimension.	Geometry properties of lines, angles, triangles and circles.

		uses. Method of holding jobs on magnetic chuck, face plate and chucks.		
31.	Table alignment with the help of test bar and dial test indicator parallel grinding and taper grinding (by swiveling machine table)	External grinding operational steps in external grinding of a job and precautions to be taken.	Free hand sketching of plan and elevation of simple objects like hexagonal bar, square bar, circular bar, taper bar and hollow bar etc.	Heat treatment tempering and normalising.
32.	Grinding of exocentric job and different types of jobs using jigs and fixtures angle plates.	Holding devices such as jig and fixture angle plates 'V' blocks etc. their description and uses.	- do -	Simple problems on lines, angles triangles and circles.
33.	Grinding of job by using face plate angle plate etc.	Internal grinding operational steps in internal grinding of a job precautions to be taken.	Free hand sketching of plan and elevation of simple job like hexagon bar square bar, circular bar, taper bar and hollow bar etc.	Heat treatment tempering and normalising.
34.	Grinding of plain/slot milling cutter.	Milling cutters and its nomenclature.	Views of simple solid and hollow bodies cut by section plane.	Trigonometry trigonometric functions of trigonometric tables-applied problems.
35.	- do -	Grinding of louses and cylinders steps and precautions to be taken.	View of simple solid and hollow bodies cut by section plane.	Case hardening and car busing.
36.	Grinding bushes and mandrel of it them within the close limit.	Rough and finish grinding limit fit and tolerances as per ISI : 919-1963. Basic size and its deviation, position of tolerances as per ISI : 919-1963. Basic size and its deviation, position of tolerance zones	Reading of simple blue print.	Calculation of areas of triangles and polygon with the aid of trigonometry.

		with respect of zero line. Fits different types clearance, interference and transition. Interchangeable system. Letter symbols for holes and shaft and fundamental deviation Hole basis and shaft system./		
37.	Dry and wet grinding of different classes of metals such as cast iron brass, bronze, aluminium, carbide tip and different classes of steel.	Heat generated in grinding dry and wet grinding use of coolant, their composition and selection. Characteristic of coolant.	Exercises on reading of drawing.	Calculation of areas of angles and polygons with aid at trigonometry.
38.	- do -	- do -	- do -	Further use of trigonometric function and tables applied problems.
39.	Grinding square block angle plate and angular block.	Grinding a square job grinding angular surface taker grinding by stane land taper and angle protractor.	Free hand sketch of trade tools.	- do -
40.	Grinding practice on drills reamers and taps.	Methods of grinding of drills reamers and taps.	- do -	Logarithm-use of logic arithmic table for multiplication and division..
41.	Grinding slitting saw and side and face milling cutter.	Methods of grinding of milling cutters such as slitting saws, side and face milling cutter etc.	Free hand sketching of simple objects related to trade and preparation of simple working drawing from sketches.	- do -
42.	Grinding slitting saw and side and face milling cutter.	- do -	- do -	Further practice in use of logarithmic tables.

43.	Checking tapered or angular jobs with help of sine bar, DTI and gauges.	Use of snap gauges, sine bar and slip gauges their description and uses.	Free hand sketching of simple objects related to trade and preparation of simple working drawing from sketches.	Reading of simple graphs.
44.	Grinding flat surfaces.	Polishing, clapping powder anemery clothes lapping flat surface.	- do -	- do -
45.	Grinding plain cylindrical milling cutter.	Tools and cutter grinder their description, working principles, operations care and maintenance.	- do -	- do -
46.	Grinding of cylindrical cutter.	Special types of grinding machines theoretical and centreless guinellers. Their description, working principles, operations, care and maintenance.	- do -	- do -
47.	Grinding internal bore of cylindrical job and use of relescopic gauge.	Grinding defects vibration, chattering, glaxing and loading their causes and remedies.	Further practice is blue print. Reading and exercises related to trade.	Reading at simple monographs.
48.	- do -	Grinding different defects and reamidity on its.	- do -	Calculation of volume and weight at simple solid bodies by using logarithms.
49.	Grinding carbide tipped tools and gauges.	- do -	- do -	- do -
50.	Grinding carbide tipped tools and gauges (rough ad finish grinding using disc and diamond wheels)	Manufacturing process of diamond wheel grinding finishing of tipped tools.	Further practice in blue print. Reading and exercises related to trade.	Revision.
51.	Making simple utility jobs with surface and cylindrical grinders. Preventive	Preventive maintenance and its necessity. Mode of frequency of	Further practice in blue print. Reading and exerciser related	Revision.

	maintenance of grinding machines.	lubrication. Preparation of maintenance schedule, simple estimation, use of hand book and reference table.	to trade.	
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2ND

YEAR.

Week No.	Practical Work	Theory	Engineering Drawing	W/s. Calculation Science
1.	2.	3.	4.	5.
1.	Machine operation and plain surface grinding practice.	Cylindrical grinding machine, its parts, use care and maintenance surface grinding machine-its parts use care and maintenance.	Care and use of Drawing Board 7-square and instruments.	Logarithmic use at logarithmic table for multiplicaton, division square, cube square root, cube root etc.
2.	Plain cylindrical and surfaces grinding practice (Maintaining parallelism) on both soft and hand metals.	Universal cylindrical grinding machines parts description use, care and maintenance. Internal grinding machine and its parts their description, use care and maintenance.	Free hand sketching of nuts and bolts.	Different forms of energy, heat mechanical and electrical example conversion from one from to other.
3.	Practice on tools and cutter grinding machine. Machine manipulation and control Mounting jobs on mrandrel. Mounting of wheel and guards sharpening of lathe tools and drill on pedestal grind etc.	Tool and cutter grinding machine-parts and accessories, description use, care and maintenance, pedestal grinder and bench grinder-their description and uses.	Preparation of drawing of nuts and bolts (dimensioning of working drawing should be explained)	Use of logarithmic table as in week No.1.
4.	Grinding practice on plain flat surface with h7 or H7.	Dial test indicators marking block, height gauge and surface plate	Reading of simple drawing of objects as far as possible	Metal and alloys, steels high speed steel, nickel,

		their description.	related to trade.	chromium steel, chrome and sterlite vanadium steel.
5.	Grinding practice on angular surface h7. Vee block grinding.	Principle of vernier, vernier caliper, protractors, micrometers (0/5, 1/s and depth) and other instruments having vernier graduations. Combination sets-their use care and maintenance.	Free hand sketching different forms of threads.	Use of logarithmic tables as in week No.1.
6.	Parallel bar grinding on cylindrical machines within close limits, plane cylindrical grinding practice to close limit with accuracy of h7.	Bonding materials their kinds description and uses. Grade and structure at grinding wheels.	Preparation of drawing of conventionalation of threads.	Metals-copper, zinc, lead, phosphorous, bronze and white metal.
7.	Step cylindrical grinding practice to close limit with accuracy at h7.	Brief above I.S.Q. 9000. Importance of Quality.	Reading of simple blue print simple.	Use of logarithmic tables as week No.1.
8.	Cylindrical bore grinding practice. Setting and turning of jobs on chucks and face plates.	Wheel marking system selection of wheels. Specification and types (shapes & size) of grinding wheels, diamond wheels and their uses.	Free hand sketching of locking devices.	F.P.S. and C.G.S. system of units of force weights etc. and their conversion problems.
9.	Balancing and mounting of grinding wheel Rt. angle grinding practice un surface grinding machine.	Mounting of grinding wheels, grinding wheels, collets and mandrels, balancing at grinding wheels by different methods.	Drawing of locking devices inditating locking in position.	Work-unit of work power, unit of power applied problems.
10.	Wheels dressing for rough and finishing grinding. Grinding a cube to close limit.	Types of dresses-steel type, abrasive Diamond tool and rotary dresses abrasive bricks and sticks their description, use, care and maintenance.	Simple exercise on blue print reading.	Simple problems on work, energy and power.
11.	Shoulder grinding practice on cylinder-grinding	Dressing and truing of grinding wheels advantage of balancing,	Free hand sketching of riveted joint.	Metals-brass, bronze, gun metal and white metal.

	machine to close limit h7.	inspections and care of grinding wheels. Wheel storage.		
12.	Slot grinding practice on surface grinding machines to close limit H7. Finding of different faults while grinding-Cracks, blow holes, chatters.	Heat generated in grinding dry and wet grinding, use of coolants their composition and selection, limit, fit and tolerances as per ISI : 919-1963. Basic size and its deviation position of tolerance zone with respect to zero lines. Fits different types clearance, interference and transition Interchangeable system Letter symbols for holes and shafts and fundamental deviation hole basis and shaft basis systems.	Free hand sketching at different types of riveted joints.	Metals-brass, bronze, gun metal and white metal.
13.	Snap gauge grinding practice in close limit.	Gauges-feeler, taper gauge radius, plug, ring snap (fixed and adjustable) and slip their description use care and maintenance.	Preparation of drawings of riveted joints.	Problems on measurement.
14.	Grinding practice on cylindrical taper using standards ring gauges.	Inside micrometer depth gauge, special types of micrometers, universal dial test indicator their construction and function.	Exercise on blue print reading.	- do -
15.	Grinding practice or ring gauge using plug gauge.	Special type of grinding machine centreless, thread crankshaft etc. their description, use care and maintenance.	Free hand sketching at keys and cutters.	Atmospheric Pressure, pressure gauges and absolute pressure vacuum.
16.	Grinding long cylindrical using steady rest to close limit h6.	Essential mechanism of grinding machines, wheel is guards to IS : 1991-1962 machine guards etc. Process of cleaning and oiling at grinding machines (dare and Maint). types if steady rests their description and use.	Preparation of drawing of keys and cutters.	Trigonometric functions use of trigonometric tables applied problems such as calculation of areas of triangles, polygons etc.
17.	Grinding thin plates	Principle types of	Free hand	Density of solids

	using coolants to close limits h6.	grinding fluids importance of uniform temperature, selection and use at grinding fluids, method of supplying grinding fluids.	sketching of pipe flanged and socket joints.	and liquids description and simple experiments.
18.	Grinding practice on parallel and taper pins using chuck and collets-h6.	Types of holding devices methods of holding work, type of centres - holdong work between centres types of chucks and holding process in chucks.	- do -	Simple problems involving trigonometric function.
19.	Selection of grinding wheel and grinding practice on rectangular bard of non-ferrous metals.	Holding work on face plate, pneumatic chuck and magnetic chuck.	Preparations of drawing on pipe joints.	Specific gravity principle of Archimeeles, Relation between specific gravity and density.
20.	Tipped tool grinding practice on surface grinding machine using universal vice.	Precautions to taken before grinding, peripheral of surface speed of grinding wheels, importance of constant wheel speeds, calculations at S.F.P.M.	Exercise on blue print reading.	Problems on trigonometry.
21.	Grinding practice on machine centre to close limit h6 or H6.	Calculation at R.P.M. and S.F.P.M. of grinding wheels calculation of work speed for cylindrical grinding speed and feeds for cylindrical grinding speed and feeds for internal grinding.	Free hand sketching at shaft coupling with keys spigotted flanged coupling forged shaft or keyed in place, cohered sleeve joint and knuckle joint, preparation of drawings of joints from sketches drawn.	Quantity of heat specific heat at solids, liquids, liquids, liquids, liquids and gases heat gained and heat lost.
22.	Facing and Chamfering practice.	Traverse and over run of traverse, width of wheel and depth of cut in different types of grinding achines. Grinding allowance and time estimation. Rough and finish grinding process.	- do -	Problem on trigonometry.
23.	Step grinding	Surface grinding	- do -	Simple problems

	practice on surface grinding machine to close limit h6 or H6.	methods of surface grinding by using periphery of grinding wheel and ring edge of grinding wheel. Types of surface grinding machines.		on heat gained and heat lost.
24.	Step grinding, practice on surface grinding machine to close limit.	Work finish, wheel selection holding of work.	Exercise on blue print reading.	Further problems on mensuration area to circle and ellipse volume and weight of sphere, calculation of area, volume and weight of simple hollow bodies problems related to the trade.
25.	Vee-block grinding practice.	Process of grinding angular surfaces. Grinding slots and grooves. Grinding "V" blocks. Recommended wheel speeds for surface grinding machines.	Free hand sketching of simple bearing with bearing blocks.	Triangle of forces and parallelograms of forces.
26.	Angular from grinding practice.	Cylindrical-types of cylindrical grinding operation traverse method, plunge cut method and form grinding method. Alignment of head stock and tail stock.	- do -	Problem on mensuration.
27.	Grinding cylindrical steps with shoulder and chamfer.	Method of plain cylindrical surface grinding step-grinding and shoulder and face grinding.	Preparation of working drawing of simple bearings.	Relation and composition of forces.
28.	Compound or double taper grinding practice on cylindrical grinder.	Method of grinding external and angle (simple) taper and steep. Taper double compound taper.	Free hand sketching or pulleys and preparation of working drawing.	Problems on measurement.
29.	Steep taper, grinding practice on lathe centre.	Use of universal head for angular grinding. Measuring and checking of taper and angles. Use of taper plug and ring gauges.	Exercise on blue print reading.	Representation of forces by vectors. Simple problems on lifting tackles like job crane, wall crane etc. and

				solution of problems with aid of sectors.
30.	Morse taper-plug grinding metric tapers.	Taper and angle checking by using protractors, micrometer and rollers.	Free hand sketching of gears spur, helical and bevel.	Problems on measurement.
31.	Taper grinding using sine bar, D.T.I. and gauge blocks to close limit h6.	Use of sine bar and gauge block-taper checking by sine bar gauge block D.T.I. micrometer and rollers.	Isometric drawing construction of isometric scales.	Moment at a force couples simple problems.
32.	Taper grinding using sine bar D.T.I. and gauge blocks to close limit h6.	Other out of round surfaces. Holding work with fixed steady rest.	Isometric view of simple objects related to trade.	Problem on mensuration.
33.	Eccentric cylinder job grinding practice.	Jig and fixture holding work by fixture and vice non-electric and magnetic chuck. Use of three jaw and two jaw steady rest.	Orthographic projection of isometric views mentioned in pre-page.	Examples on simply supported and loaded beams.
34.	Grinding Taper up to close limit H6. Grinding lathe centre.	Grinding parallel and step bore grinding internal taper, centreless grinding process of holding job, and types of operations. Effect of setting work above and below wheel centre.	Views of simple solid out by section planes true view at section.	Problems on measurement.
35.	Internal step grinding to close limit, ring gauge, grinding to close limit-H6. Grinding of single angle cutter.	Internal centreless grinding methods of holding jobs and processes of grinding. Selection of wheels. Internal grinding work movement and wheel movement. Rotation and reciprocation of job and wheel spindle, Internal grinding allowance, selection of wheels for internal grinding allowance, selection of wheels for internal grinding. Thread grinding method of holding jobs methods of	- do -	General condition of equilibrium. For series of forces acting on a body.

		grinding threads and thread calculation.		
36.	Cylindrical slot grinding to close limit h5.	Thread grinding method of holding jobs method of grinding threads and thread calculation.	Development of surfaces of simple objects.	Plotting of points plotting of graphs of simple equation and reading of graphs.
37.	Grinding of angular cutter by using work head.	Various types of thread grinding wheels and their selection. Types of dressers and process of process of dressing selection of coolants and their use.	Development of surface of simple objects.	Simple problems on inclined plane.
38.	Tool grinding practice.	Off hand grinding, grinding of various lathe tools maintaining tools angles for different types of metals.	Construction of simple curves of interpretation.	Reading and plotting of simple graphs.
39.	Sharpening tools and drills, sharpening scrapers and chisels.	Grinding boring tools shaping tools, slotting tools, tools planning and drills, grinding of scrapers, chisels and carbide tipped tools. Selection of wheels fluids etc. and methods of grinding.	- do -	Centre of gravity, simple experimental determination.
40.	Carbide tied tool grinding.	Grinding defects and their corrections, inaccurate work out of round, out of parallel taper on and, irregular marks spiral scratches, discoloured burnt surface etc.	Development of surfaces.	Reading and plotting at simple graphics.
41.	Form grinding radius angle, Grinding of concave & convex cutter.	Grinding defects and their correction. Waxiness mass of surface, chatters-short close evenly spaced long and regularly spaced, marks in phase with vibration of floor, random marks, random waves etc. Glazing of wheel and loading of wheel.	- do -	Stable, unstable and neutral equilibrium of bodies simple explanation.
42.	Slitting saw sharpening practice	Cutter grinding necessity of sharpening. General	Free hand sketching of	Reading and plotting of simple

	using tooth rest.	method of sharpening milling cutters-clearance angles. Use of setting gauges.	small parts related to trade.	graphs.
43.	Grinding straight & fluted reamer.	Method of indexing direction of wheel rotation, wheel dressing. Types of cutter grinding wheels and their selection.	- do -	Simple estimation on the requirement of material etc. related to trade.
44.	Side and face milling cutter sharpening practice.	Methods of linear settling and direct setting. Types of tooth rests and their location.	- do -	Friction limiting of friction, law of friction, coefficient of friction angle of friction.
45.	Spiral milling cutter sharpening practice.	Calculation of clearance angle. Setting for cup wheels and straight wheels. Recommended clearance angles for different materials to be cut primary and secondary clearance width of lands.	Free hand sketching of detailed components from assemblies.	Mechanical advantage velocity, ratio and efficiency of simple machines.
46.	Sharpening side and face milling cutter.	Sharpening methods of plain or key way cutters Grinding peripheral teeth on a side and face milling cutter use of indexing attachment.	Free hand sketching of detailed parts and production of working drawings of machine parts such as tool herders, machine vice, part of shapers, planer millers, grinder etc.	Problems on simple estimation.
47.	Sharpening end mill cutter.	Sharpening of helical milling, cutter using linear and angular setting methods. Sharpening spind end mill and angular cutters,	Production of working drawing.	Simple problems on work, energy and power.
48.	Tap grinding (sharpening) practice, having practice.	Grinding flutes of form cutters, grinding taps, reamers, similar types of cutting tools, use of universal attachment Hous and having Typing of having stones-their	Production of working drawing.	Problems on simple estimation.

		description and use. Amount and rate of stock removal. Adjustment for elementary having condition, having tolerances. Having of carbide tipped tools.		
49.	Lapping practice on flat surface.	Laps and lapping material laps types of taps lapping abrasives- rotary diamond lap- lapping lubricants lapping pressures wet and dry lapping.	Exercise on blue print reading.	Magnetic substance natural and artificial methods of magnetisation use of magnets.
50.	Lapping practice on cylindrical surface and buffing practice to very close limit h5.	Hand lapping and machine lapping. Lapping flat surface lapping cylindrical surface polishing wheels abrasive buffing wheels.	Revision and exercises on blue print reading.	Simple electric circuit Ohm-law.
51.	Job checking and job evaluation practice.	Description and uses of special types of measuring instruments comparators projectors etc. Estimation of material and cost. Modern new developments in the trade.	- do -	Revision

NOTE :- During this period of training the trainees should be given the actual parts or components as many as possible mostly related to trade and asked to make proportionate free hand sketching indicating actual dimension from the sketching made. The trainees should further be asked to produce working drawing using small board 7-square and drawing instruments. Blue print reading should also continue in the second year. Instructions should be given to trainees on the normal standard practice followed in drawing. The syllabus given is a guide for the teacher.

TRADE - MACHINIST (GRINDER)

List of I.S.I. books for use of the Instructors.

Sr.No.	Titles	I.S.I.Code No.
1.	Test chart for cylindrical grinders	IS : 2368-1963
2.	Test chart for horizontal surface grinders	IS : 2748-1964
3.	Universal tool and cutter grinders, test charts for	IS : 3080-1960
4.	Truing tools, single diamond	IS : 2974-1964
5.	Mounting dimensions for grinding wheels	IS : 2996-1964
6.	Feeds for machine tools	IS : 2219-1962
7.	Speeds for machine tools	IS : 2218-1962
8.	Code of testing machine tools	IS : 2063 - 1962
9.	Coolant pump for machine tools	IS : 2161-1962
10.	Direction of operation of controls for machine tools, recommended for.	IS : 2987-1965
11.	Sizes for machine tools tables	IS : 2642-1964
12.	Machine vices	IS : 4502-1968
13.	Dimensions for diamond grinding wheels	IS : 3264-1965
14.	Grinding wheels dimension for	IS : 2324-1963
15.	Grinding wheels, safety code for	IS : 1991-1962
16.	Dimensions for mounted points	IS : 3300-1965
17.	Marking systems for grinding wheels	IS : 551-1966
18.	Recommendation for selection of grinding wheels	IS : 1249-1958
19.	Tapers for general Engg. purposes	IS : 3458-1966
20.	Limits and fits for general engg. recommendations.	IS : 919-1963
21.	General Engineering drawing code of practice for	IS : 696-1960
22.	Dial gauges	IS : 2092-1962
23.	External micrometers	IS : 2967-1964
24.	Internal micrometers	IS : 2966-1964
25.	Feeler gauges	IS : 3179-1965
26.	Vernier calipers	IS : 3651-1966
27.	Vernier height gauges	IS : 4213-1967
28.	Vernier depth gauges	IS : 2949-1964
29.	V-blocks	IS : 2554-1963
30.	C.I.angle plates	IS : 2554-1963
31.	Slip gauges	IS : 2984-1966

TRADE - MACHINIST (GRINDER)

**List of tools/equipment for first year course
(For a batch/unit of 12 trainees)**

Sr.No.	Description	For Trainees	For Trainees
1.	2.	3.	4.
TRAINEES TOOL KIT			
1.	Steel Rule 150mm (graduated both English and Metric).	1	12
2.	Try Square Engineer 150mm	1	12
3.	Outside Calipers (spring) 250mm	1	12
4.	Inside Calipers (spring) 150 mm	1	12
5.	Hammer Ball Pein with handle 0.50 kg.	1	12
6.	Odd leg Caliper 150 mm	1	12
7.	Scriber 150 x 3 mm	1	12
8.	Plier 150 mm	1	12
9.	Goggles (fiber plastic cup) safety glasses (interchangeable glasses)	1	12
TOOLS MEASURING INSTRUMENTS AND GENERAL SHOP OUT FIT			
M 1.	Hammer Copper 0.50 kg.	-	2
M 2.	Hammer Engineers, Ball Pein 0.50 kg.	-	2
M 3.	Scribing Block with adjustable Vertical spindle 225 mm 4 Angle Plate, adjustable (graduated in degrees) 150 x 150 x 150 mm	-	2
M 7	Blocks Vee 150 x 100 x 100 mm (fitted with clamps, hardened and ground)	-	2 Pair
M.8	Blocks Vee (grooved and fitted with clamps) (Hardened and ground) 75 x 75 x 50 mm	-	2 Pair
M.10	Block parallel, adjustable 150 mm long, 42 mm wide, 18 mm height (hardened and ground)	-	2 Pair
M.11	Block, parallel, adjustable 100 mm long, 50 mm wide, 32 mm height (hardened and ground)	-	2 Pair
13	Calipers, Vernier 200 mm, inside and outside (graduated in inches and millimeters_	-	1 each
14	Calipers, Vernier, outside 300 mm (graduated in inches and millimeters)	-	4 Nos.
15.	C-clmps 50 mm, 100 mm and 150 mm	-	2 Each

M.16	Oilcan, Pressure delivery ¼ point capacity	-	4
M.17	Oilcan Drip delivery (long spout) point capacity	-	4
M 18.	Height Gauge (Metric and English graduated)	-	1
M 19.	Combination set (consisting of 300 mm rule centre)	-	2
M 20.	Comparator Gauge, complete with stand and brackets.	-	2
M 21.	Chuck, Drill 12 mm cap. (Taper shank)	-	1
M 22	Chuck, Drill 16 mm capacity (Taper shank)	-	1
M 23.	Dial Test Indicator complete with stand (universal type with magnetic base 1/100 mm)	-	2
M 24.	Diamond, Wheel Dressing (single stone mounted)	-	4
M 25.	Files, Hand Flat, 200 mm smooth	-	8
M 26.	Files, Hand Flat, 250 mm smooth	-	8
M 27.	Files, 150 mm Half round smooth	-	8
M 28.	Files, round Dead smooth 200 mm	-	4
M 29.	Files, Triangular, Deads smooth 200 mm and 150 mm	-	2 Each
M 30.	Files, Trianglar Dead mooth 150 mm	-	4
M 31.	Feeler Gauge Metric Set	-	1 Set
M 32.	Gauge Radius (Inside and Outside) (Metric)	-	2
M 33.	Gauge, Slip (Metric)	-	2 Sets
M 34.	Gauge, Telescopic 12 to 150 mm	-	2 Sets
M 35.	Gauge, Morse Taper, Plug Nos. 1,2,3,4	-	1 Each
M 36.	Gauge, Morse Taper, Ring Nos. 1,2,3,4	-	1 Each
M 37	Glass, Magnifying 250 x 25 x 75 mm dia with handle	-	1
M 38	Hacksaw from 200 to 300 mm adjustable	-	2
M 39	Keys, Allen 1 mm to 14 mm by 1 mm	-	4 Sets
M 40	Keys, Allen 3 to 12 mm, by 1.5 mm	-	1 Set
M 41	Spirit Level, Engineers 25 mm precision	-	1
M 42	Micrometer outside 0 to 24 mm and o" to 1" size (Vernier)	-	3 Each
M 43	Micrometer outside 25 to 50 mm and 1" and 2" (Vernier)	-	2 Each
M 44	Micrometer 0/5 50 to 75 mm and 2" to 3"	-	1 Each
M 45	Micrometer)/5 75 to 100 mm and 3" to 4"	-	1 Each
M 46	Internal Micrometer 25 to 150 mm and 1" to	-	1 Each

	6" with extension Rods.		
M.47.	Depth Gauge Micrometer with extension rods to 150 mm with 70 mm Base and 0" to 6" with extension rods with 3" Base	-	1 Each
M.48	Oil Stone Carborandum, Coarse on one side and fine on the other 200 x 50 x 25 mm	-	2
M.49	Oil Stone Carborandum, Coarse on one side and fine on other slip 100 x 12 mm triangular.	-	2
M.50.	Oil Stone Carborandum, Coarse on one side and fine on other slip 100 x 18 mm triangular	-	2
M.51	Square, Try, Engineer's 100 mm blade	-	2
M.53	Straight Edge Engineer's 300 x 50 x 12 mm bevelled edge.	-	1
M.54	Screw Driver 200 mm blade	-	2
M.55	Screw Driver 300 mm blade	-	2
M.56	Spanner D.E. open jaw 3 to 18 mm by 3 mm	-	2 Sets
M.57	Sine Bar Plate to suit above	-	1 Each
M.58	Sine Bar Plate to suit above	-	1 Each
M.59	Scraper Flat 25 x 200 mm with handle	-	2 (1 Each)
M.60	Scraper Half round 75 x 12 x 200 mm with handle	-	2
M.61	Scraper Triangular 62 x 9 x 200 mm with handle	-	2
M.62	Techometer with male and female rubber attachments (upto 0-10,000 RPM)	-	1
M.63	Table Chuck 75 mm Jaw Swivel Base 200 mm dia	-	1
M.64	Table Chuck 3 Jaw with tilting arrangement and graduated in degrees	-	1
M.65	Vices, Machine Plain 150 Jaws x 100 mm openings	-	2
M.66	Vices, Machine, Swivelling Base 150 mm x 100 mm	-	2
M.67	Vice Universal for Grinding, Machine 4"	-	2
M.68	Wheel Dressers, Steel Type (Hintington) (Large)	-	2
M.69	Radius Truing Attachment for surface grinding machine	-	1
M.70	Wheel Dressers, Steel (Hintington type Small)	-	3
M.71	Radius Truing Attachment for cylindrical grinding machine.	-	1

M.72	Angle Truing Attachment for surface grinding machine.	-	1
M.73	Demagnetizer Chuck	-	1
M.74	Centre Punch 150 x 6 mm dia	-	4
M.75	Reamer Adjustable 6 to 16 x 1.5 mm	-	1 Set
A.76	File Flat Rough 300 mm	-	4
A.77	File Flat 250 mm Second Cut	-	4
A.78	Chisel Cold Flat 18 mm	-	4
A.79	Chisel Cold Flat 12 mm	-	4
80.	Surface Plate 60 x 60 cms	-	1
81.	Marketing Table 90 x 60 x 90 cms	-	1
A 82.	Hand Drill 6 mm	-	1 Set
A.83	Taps and Dies complete set in box (Metric)	-	1 Set
A.84	Taps and Dies set B.A.B.S.F.B.S.W. and American	-	1 Set
A.85	Drill Twist (Straight Shank) 1/8" to 1/2" by 1/64"	-	1 Set
A.86	Drill Twist (Metric) 3 mm to 12 mm, in step of 1 mm	-	1 Set
A.87	Set of Morse (Sockets (0-1, 1-2 and 2-3)	-	1
A.88	Drill Chuck 0 to 12 mm Morse Taper	-	1
89.	Combination Drill (Centering)	-	2
90.	Screw Pitch Gauge	-	2
91.	Working Benches 340 x 120 x 75 cms with 4 bench vices, 125 mm jaw	-	1
S.92	Fire Extinguisher	-	1
S.93	Fire Buckets with stand	-	4
94	Steel lockers with 6 drawers	-	2
95	Metal Rack 180 x 150 x 45 cms	-	1
96	Desk	-	1
97	Stool	-	1
98	Black Board with Easel	-	1
A 99	Magnifying Glass with surface illuminator	-	1
A 100	CMTI surface finish standards (in Bakelite)	-	1 No.
A 101.	Adjustable Wrench 250 mm size	-	1
A 102.	Hammer (Nylon face) 30 mm	-	4
A 103.	Crease Gun	-	2
A 104.	Magnetic V-Block with push button switch	-	1 Set
A 105.	Magnetic V-Block base for Dial Indicator 75 x 75 x 100 mm	-	2 Nos.
A 106	Diamond Dresser Cluster type	-	2 Nos.
A.107	Adjustable Parallel Clamps (Hardened and	-	2 Pairs

	ground) 100 mm long		
108.	Granite Stone Surface Plate Grade A 600 x 500 x 1000 mm	-	1 No.
109.	Static balancing stand for grinding wheel	-	1 No.
110.	Soft Board for display 1.25 mm x 1.85 mm x 10 mm thick	-	1 Nos.
A.111	Dial Test Indicator-Lever type-long point	-	2 Nos.
A.112	Magnetic Stand Flexible type base 60 mm x 47.5 mm Magnetic Power 75 kg. ON-OFF Lever control	-	2 Nos
A.113	Cutter Clearance Gauge to Suit Clearance all cutter diameters angle 0"-30".	-	1 Set
A.114	Indicating Micrometer 0.25 mm range, graduation, 01" mm graduation of dial 0.001 mm range of dial + 0.02	-	1 No.
M.115.	Glass Show Case for display of jobs 450 mm x 600 x 850 mm	-	1 No.
Desirable :-			
1.	Shadeograph projector with diascopic and epidiascopic projection, magnification 50, 100, 200, rotary screen 1 minute accuracy and centering, attachment.	-	1 No.
GENERAL MACHINERY			
S.1	Lathe 75 cm between centres x 180 cm centre height 4 jaw independent chuck, self centering chuck set of lathe tools, lathe carriers etc. complete.	-	2
S.2	Drilling machine pillar 0-12 capacity	-	1
S.3	Grinding machine external cylindrical fully motorised and supplied with face plates and driving dogs, 3-jaw self centering chuck 4-jaw independent chuck tail stock assorted centres, stud pumps tank all guards and pipe fittings spanners and grease gun (each machine to be supplied with assorted grinding wheels for general purpose work with internal grinding attachment)	-	2
S.4	Grinding machine plain surface, wheel dia. 175 mm (or near) with reciprocating table having longitudinal table traverse 200 mm (or near) fully automatic and fitted with	-	2

	adjustable traverse steps, machine to be fully motorised and fitted with ace guards and pumps, tank and pump fittings and also to be supplied with magnetic chuck 250 x 112 mm. Diamond tool holder, set of spanners, grease gun, oil-can and spare grinding wheel for general purpose grinding.		
S.5	Grinding machine plain surface with horizontal and vertical spindle, reciprocating table having longitudinal table traverse fully motorised and supplied with set of spanners, necessary equipment, diamond tool holders for wheel sized 175 x 30 x 18 mm suitable cup wheels for vertical spindle, spare wheel proper guards and coolant pump with fittings.	-	2
S.6	Tool and cutter grinding machine of size 250 x 375 mm fully motorised supplied with chuck, centres tool rest, height gauge, table clamps universal vice tooth rest. Diamond dressing tool and holding attachment equipment for tool grinding and assorted grinding wheels for all tool room work (with twist drill grinding attachment).	-	2
S.7	180 x 90 x 180 cm lapping machine with motor and chuck 132 cm dia.	-	1

NOTE :-

- (1) No additional items are required to be provided for the batches working in the second shift except the items under the trainees tool kit and lockets.
- (2) Additional number of items marked 'S' are not required to be provided for additional number of batches.
- (3) Items marked 'A' are to be obtained from the main store.
- (4) The specifications of the items in the above list have been given in metric units. The items which are available in the market nearest to the specifications as mentioned above if not available as prescribed., should be produced. Measuring instruments such as steel rules which are graduation both in English and Metric units may be produced, if available.
- (5) Simple hand tools for fitting etc. such as hammers, scribing blocks, V-block parallel block, angle plate Allen keys centre punch, oil cans etc. mentioned in the above list and marked 'M' may be made in the Institute as far as possible.

**ADDITIONAL LIST OF TOOLS AND EQUIPMENTS REQUIRED
FOR SECOND YEAR COURSE
(For a batch of 12 trainees)**

Sr.No.	Description	For Instructor	For Trainees
1.	2.	3.	4.
GENERAL MACHINERY			
1.	Grinding machine universal, machine to be motorised and supplied with assorted arbors spindles for internal work, 3-jaw self centering chuck, 4-jaw independent chuck face plate driving dogs, tail stock and centres, machine to be completed with all guards, sud and driving dogs, 3-jaw self centering chuck pump and tank, pipe fittings, diamond tool holder fixtures, radius dressing attachment and with spanners (internal and external) and general purpose grinding cylindrical magnetic chuck (permanent) 2,000 mm dia.	-	2
2.	Small type hand honing machine with motors sand and bracket and with sets of different types of honing stones and other accessories.		
3.	Lathe machine with taper turning attachment 4-jaw chuck and 3-jaw chuck.		

**LIST OF OPERATIONS/SKILLS TO BE LEARNT
DURING APPRENTICESHIP**

Sr.No.	List of operation/skills to be learnt during Apprenticeship
1.	Introduction in safety precautions as applicable to the trade.
2.	Marketing out drawings in mm/inch.
3.	Filing to line.
4.	Chipping.
5.	Grinding of chisels.
6.	Hacksawing.
7.	Drilling.
8.	Reaming.
9.	Tapping.
10.	Threading with dies.
11.	Use of micrometers and verniers.
12.	Use of other precision measuring instruments,

	e.g. Dial Test Indicator etc.
13.	Simple fitting using spanners pilers, etc.
14.	Identification of ferrous and non-ferrous metals used in the trade.
15.	Scraping.
16.	Centering.
17.	Plain turning.
18.	Step turning.
19.	Taper turning.
20.	Thread cutting in lathe (external and internal)
21.	Use of chucks.
22.	Use of facing tools.
23.	Drilling using tail stock.
24.	Boring.
25.	Plain cylindrical grinding (external)
26.	Plain cylindrical grinding (internal)
27.	Taper cylindrical grinding (external)
28.	Taper cylindrical grinding (internal)
29.	Grinding of long cylindrical surfaces using steadies.
30.	Grinding of flat end taper surfaces.
31.	Grinding of tipped tools.
32.	Grinding of milling cutters.
33.	Grinding of taps.
34.	Use of jigs and fixtures for grinding .
35.	Use of appropriate coolants.
36.	Selection of appropriate grinding wheels.
37.	Selection of correct of speed and feed.
38.	Mounting, balancing and truing of grinding wheels.
39.	Dressing and truing of grinding wheels.
40.	Working from engineering drawing dimensioned in mm/inch.
41.	Preventive maintenance of grinding machines.
SHIP TRAINING : 2 YEARS	
42.	Instruction in safety precautions o the Shop Floor.
43.	Hardening and tempering.
44.	Case hardening.
45.	Use of hardness tester
*46.	Grinding of lathe tools.
47.	Grinding within an accuracy of = 0.005 mm.
*48.	Simple form of grinding.
*49.	Face and shoulder grinding.
*50.	Grinding cutting tools.
*51.	Grinding of reamers.
*52.	Grinding of drills.

*53.	Thread grinding.
*54.	Use of universal grinding machine.
*55.	Setting up of centreless grinding machine.
*56.	Lapping and honing.

NOTE :-

The operations/skills marked (*) are desirable. They must be carried out where the facilities are available in the establishment.

SYLLABUS FOR RELATED INSTRUCTION

Related Instruction should be imparted to all the apprentices during the entire period of training including "Basic Training". The syllabus given for Related Instruction should be considered as a guide.

The subjects to be taught to the apprentices in Related Instruction are as follows :

1. Trade Theory.
2. Workshop Calculation and Science.
3. Engineering Drawing.
4. Social Studies.

FIRST YEAR

The content of the syllabus for the apprentices during first year training should be same as the content of the first year of two years course for the I.T.I. trainees in this trade.

SECOND YEAR

The content of the syllabus for the apprentices during second year training should be same as the content of the second year of two years course for the I.T.I. trainees in this trade.

THIRD YEAR

(A) TRADE THEORY

(3 hours per week or 150 hours per year approximately)

(The number of hours to be spent on different topics in Trade, Theory has been indicated. The hours indicated are flexible and are only intended as a guide)

1.	Safety at work-accident do not happen they are caused.	:	6 hours.
2.	Revision of the work of previous two years.	{	
3.	Limits, fits and tolerances - IS : 919-1963	{	10 hours
4.	Description of machine tools such as centre lathe, capstan, turret, copying and relieving lathes, shaping, slotting and planning m/c horizontal, vertical and universal milling machines etc. Their use and relationship to each other, particularly the grinding machines.	:	12 hours
5.	Dividing head and other indexing methods, Calculation for indexing.	:	3 hours
6.	Method of checking or measuring screw threads with particular reference to thread grinding.	:	2 hours
7.	Importance of proper use of Lubricants and coolants their practical application.	:	6 hours
8.	Routine maintenance.		
9.	Bearing types hydrostatic segmental bearings in grinding machines, its importance in accuracy obtained on work pieces.	:	6 hours
10.	Shop layout.	:	3 hours
11.	Laps and lapping honing.	:	3 hours
12.	Use of tables and manufacturer's hand book.	:	4 hours
13.	Modern developments in the trade-new techniques etc.	:	3 hours
14.	Now abrasive grain Boron nitride abrasive wheels application advantages.	:	3 hours
15.	Inspection-reduction of scrap by/stage inspection.		
16.	Internal taper checking ball method.		
17.	Hardness testing, different principles. Hardness conversion tables.	:	6 hours
18.	Introduction to work simplification related to the trade job study, job analysis including planning of sequence of operation. Critical approach and method of working. Estimation of time and material, job handling.	:	30 hours
19.	(i) Basic Principles of Hydraulics Pascal's Law. Brahma Oress Gtdraykuc Forces acting on pistons and rams-problems.	:	15 hours
	(ii) Types of Hydraulic fluids advantage and disadvantages.		
	(iii) Generation transmission and utilisation of Hydraulic Power-general ideas.		
	(iv) Components of Hydraulic System Tank, Pump filters strainers oil seats, Using pressure switches, pressure controls, flow controls, direction controls, liner cylinder		

- single action/double action.
- (v) Hydraulic circuit as applied to Grinding machines.
- (a) Actuation of Table-Dwell at both ends of the table.
Control of Table speed.
- (b) Wheel Head Actuation-Rapid approach and retraction
cushioning at forward and backward coarse feeding
feed-spark cut.
- (c) Tall stock actuation clamping by force, unclamp by
Hydraulics.
20. (1) Factors affecting ordering of new grinding wheels : 2 hours
(Designation)
- (2) G. ratio in grinding. : 1 hour.
- (3) Use of mounted points, segmental wheels reinforced : 1 hour
wheels in grinding operations abrasive cut of wheels.
- (4) Diamond wheels specification grit, bond : 1 hour
concentration, peripheral speeds, standard shoes, case
and maintenance.
21. Further work on Heat treatment. Heat treatment of metals: 11 hours
annealing, hardening, tempering, normalising and case
hardening, Heat treatment of cutting tools.
Stress relieving necessity for and methods.
22. Quality and finish of work-Importance of quality and finish: 8 hours
of jobs at all stages-production of finished surfaces, removal
of sharp edges etc., surface finish-introduction to surface finish
I.S.I. symbols for surface finish and their interpretation. Surface
finish grades in grinding operations.
23. Description of special purposes grinding machines used : 6 hours
in production work.
24. Revision and test. : 10 hours

(B) WORKSHOP CALCULATION AND SCIENCE
(1 hour per week or 50 hours per year approx.)

1. Revision of the work of previous two years.
2. Further problems as applicable to the trade.
3. Further problems on menstruation, work, power and energy.
4. Meaning of tenacity, elasticity, malleability, brittleness, hardness,
compressibility and ductility.
5. Meaning of stress, strain, modulus of elasticity, ultimate tensile strength
factor of safety and different types and stresses.
6. Gear and belt drivers, Determination of horse power, speed and size of
pulleys and gears.

7. Difference between pressure and force.
8. Velocity, acceleration and retardation.
9. Descriptive explanation of expansion of heat-solids liquids and gases due to heat co-efficient of expansion. Brief description of transference of heat-conduction convection and radiation.