SRI VENKATESWARA COLLEGE OF ENGINEERING & TECHNOLOGY (AUTONOMOUS)

Accredited by NBA, AICTE New Delhi & NAAC Bangalore

(Affiliated to JNTUA, Anantapur)

RVS NAGAR, CHITTOOR.

DEPARTMENT OF MECHANICAL ENGINEERING

MACHINE TOOLS AND MEASURING SYSTEMS LAB (20AME24)

III B.TECH-I SEMESTER

Name of the Student: ………………………………………………………………

Roll No : ………………………………………………………………

Year & Semester : ……………………………………………………………….

Department : ……………………………………………………………….

SRI VENKATESWARA COLLEGE OF ENGINEERING AND TECHNOLOGY
(AUTONOMOUS)
R.V.S. NAGAR, CHITTOOR-517 127, ANDHRA PRADESH
DEPARTMENT OF MECHANICAL ENGEERING

Vision of Mechanical Engineering

Providing excellent technical education in Mechanical Engineering with the help of state of art infrastructure and carvethe youth to suit the global needs.

Mission of Mechanical Engineering

Provide excellent Teaching-Learning process using state of art facilities to help a holistic growth in the disciplines of Thermal, Design, Manufacturing, Management and Quality areas with an emphasis on practical applications. Stimulate innovative thinkingleading to higher learning.

Programme Educational Objectives (PEO's) of UG:

PEO1	Pursue higher education in the varied fields of mechanical engineering and management.
PEO2	Secure a career placement in core and allied areas
PEO3	Develop skills to undertake entrepreneurship and lifelong learning

PROGRAMME SPECIFIC OUTCOMES (PSOs) of UG

PSO1	Apply the knowledge of manufacturing, thermal and industrial engineering to formulate, analyze and provide solutions to the problems related to mechanical systems
PSO2	Apply the design concepts and modern engineering software tools to model mechanical systems in various fields such as machine elements, thermal, manufacturing, industrial and inter-disciplinary fields.

DO'S

- Wear uniform, shoes & safety glasses
- Please follow instructions precisely as instructed by your supervisor.
- If any part of the equipment fails while being used, report it immediately to your supervisor.
- Students should come with thorough preparation for the experiment to be conducted.
- Students will not be permitted to attend the laboratory unless they bring the practical recordfully completed in all respects pertaining to the experiment conducted in the previous class.
- All the calculations should be made in the observation book. Specimen calculations for oneset of readings have to be shown in the practical record.
- Wherever graphs are to be drawn, A-4 size graphs only should be used and the same shouldbe firmly attached to the practical record.
- Practical record should be neatly maintained.
- Students should obtain the signature of the staff-in-charge in the observation book aftercompleting each experiment.
- Theory regarding each experiment should be written in the practical record before procedurein your own words.

DONT'S

- Do not touch hot work piece
- Do not start the experiment unless your setup is verified & approved by your supervisor.
- Do not leave the experiments unattended while in progress.
- Do not crowd around the equipment's & run inside the laboratory.
- Don't wear rings, watches, bracelets or other jewellery
- Don't wear neck ties or loose turn clothing of any kind.
- Do not eat or drink inside labs.
- Do not wander around the lab and distract other students
- Do not use any machine that smokes, sparks, or appears defective

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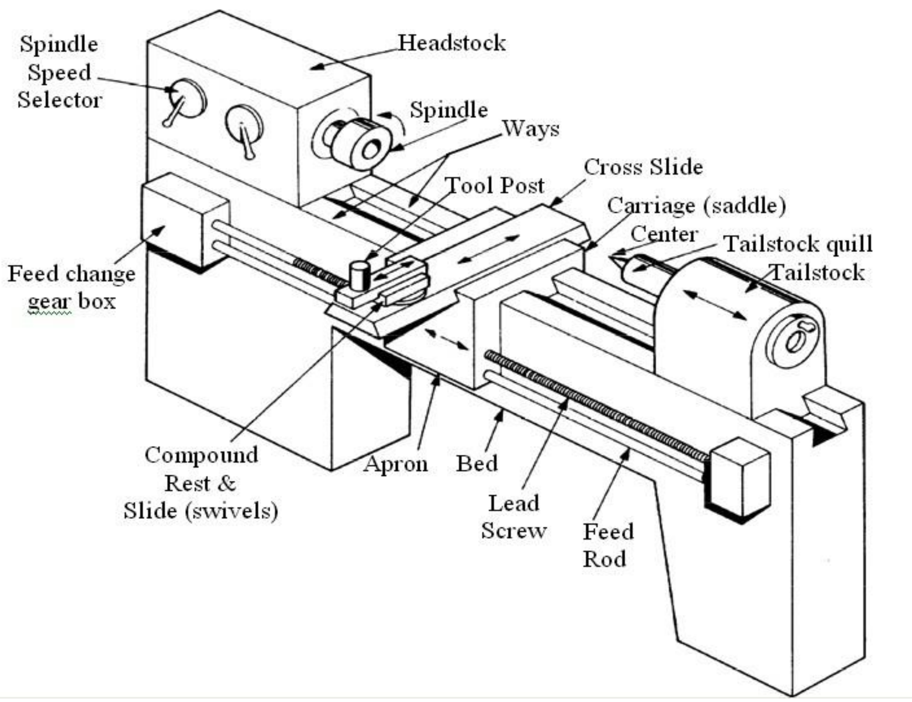
MACHINE TOOLS

PURPOSE OF MACHINES:

Various machine tools are used for making the different shapes of the jobs. These machine tools are different types, those are as follows. Lathe machine, Shaper machine, Slotting machine, Planning machine, Drilling machine, Boring machine, Milling machine, Grinding machine, Lapping machine, Honing machine and Broaching machine. These machines are to producing various operations like namely Facing, Chamfering, Step turning, Taper turning, Plain turning, Knurling, Grooving, Thread cutting, Drilling, Tapping, Precision grinding, Cylindrical grinding, Surface grinding, grinding of tool angles.

LATHE MACHINE



A lathe is a machine tool which rotates the work piece on its axis to perform various operations such as turning, facing, knurling, drilling, or deformation with tools that are applied to the work piece to create an object which has symmetry about an axis of rotation.

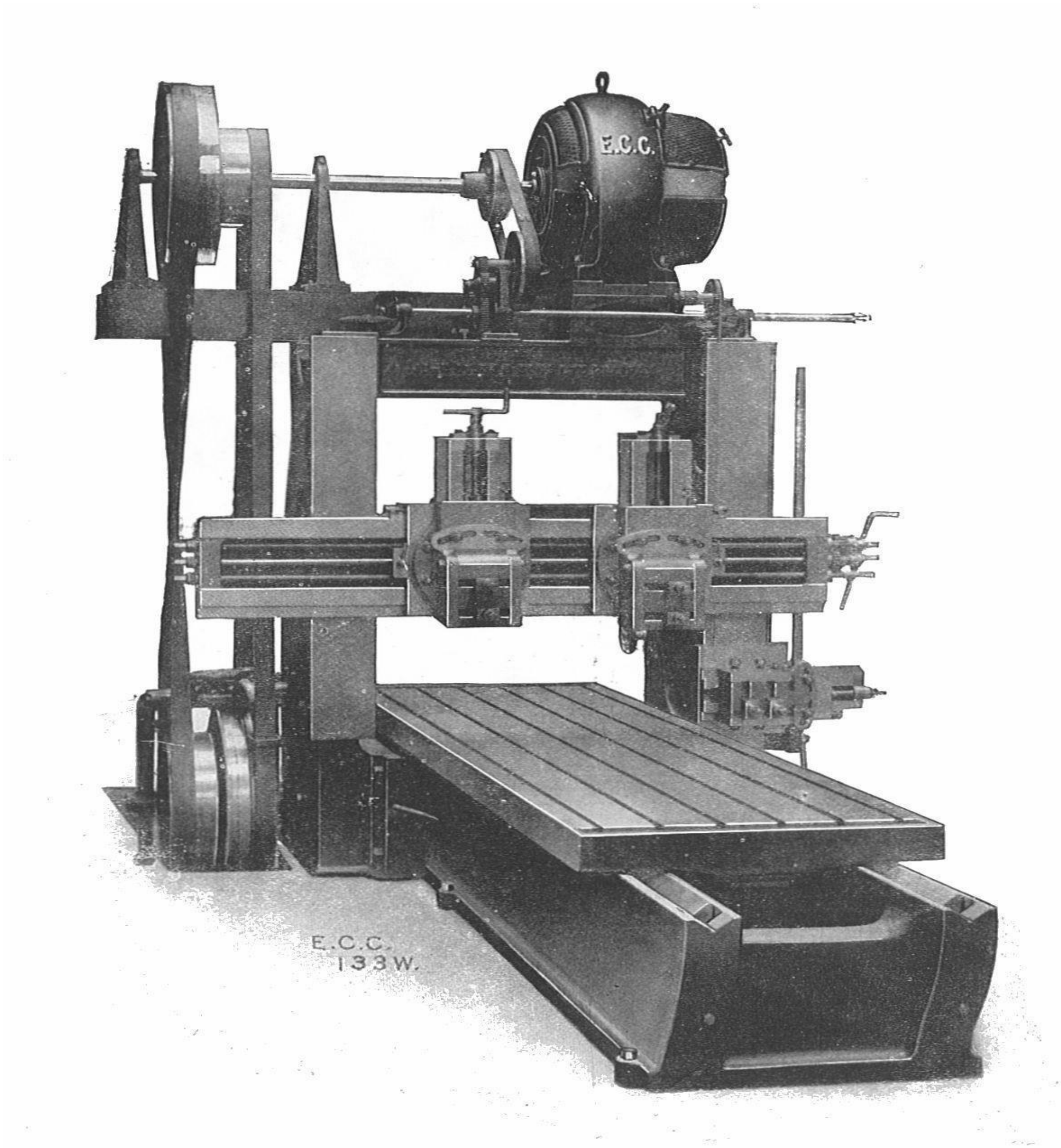
Lathes are used in woodturning, metalworking, metal spinning, and glass working. Lathes can be used to shape pottery, the best-known design being the potter's wheel. Most suitably equipped metalworking lathes can also be used to produce most solids of revolution, plane surfaces and screw threads or helices. Ornamental lathes can produce three-dimensional

Solids of incredible complexity. The material can be held in place by either one or two centers, at least one of which can be moved horizontally to accommodate varying material lengths. Other work holding methods include clamping the work about the axis of rotation using a chuck to a faceplate, using clamps or dogs.

SHAPER MACHINE:

A shaper is a type of machine tool that uses linear relative motion between the work piece and a single-point cutting tool to machine a linear tool path. Its cut is an amorous to that of a lathe, except that it is linear instead of helical. (Adding axes of motion can yield helical tool paths, as also done in helical planning.) A shaper is analogous to a planer, but smaller, and with the cutter riding a ram that moves above a stationary work piece, rather than the entire work piece moving beneath the cutter. The ram is moved back and forth typically by a crank inside the column; hydraulically actuated shapers also exist.

PLANNING MACHINE:



A planer is a type of metalworking machine tool that uses linear relative motion between the work piece and a single-point cutting tool to machine a linear tool path. Its cut is analogous to that of a lathe, except that it is linear instead of helical. (Adding axes of motion can yield helical tool paths; see "Helical planning" below.) A planer is analogous to a shaper, but larger, and with the entire work piece moving on a table beneath the cutter, instead of the cutter riding a ram that moves above a stationary work piece. The table is moved back and forth on the bed beneath the cutting head either by mechanical means, such as a rack and pinion drive or a lead screw, or by a hydraulic cylinder.

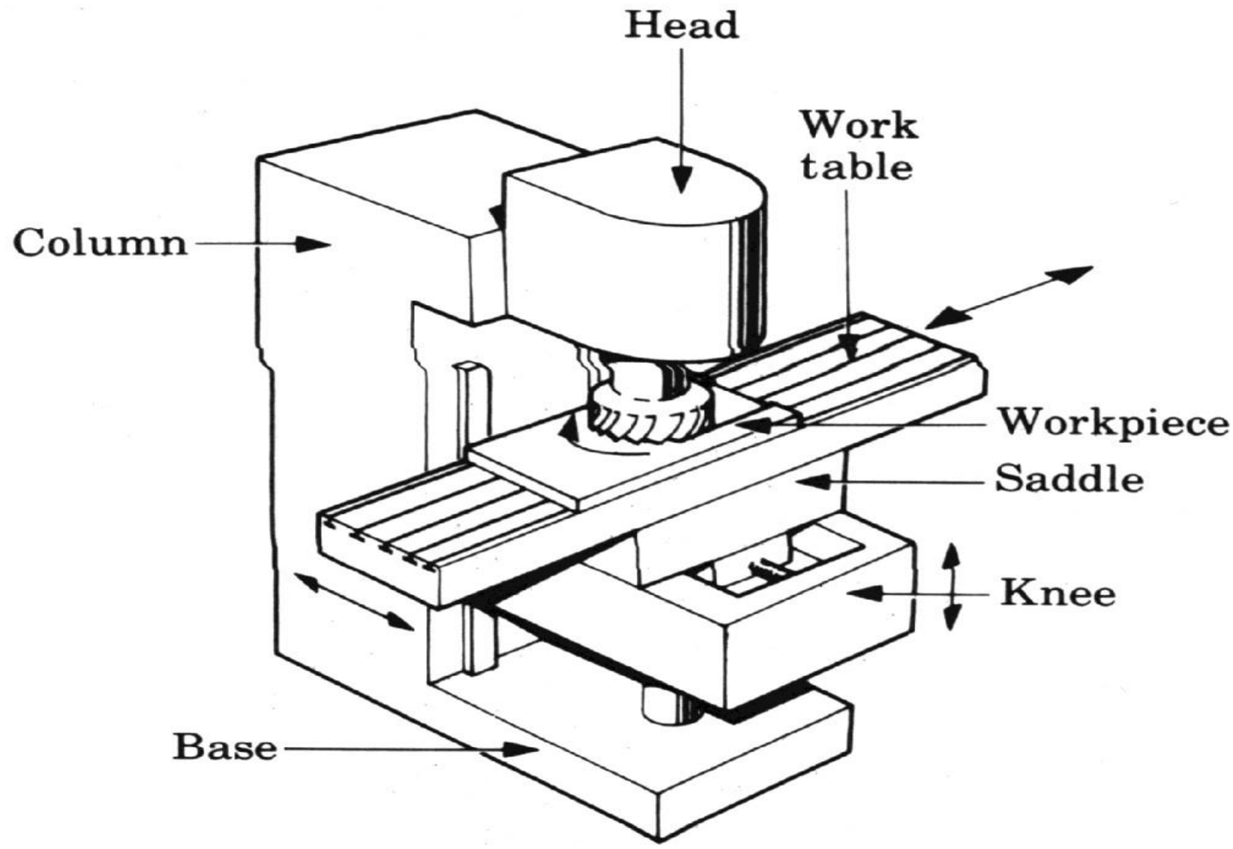
DRILLING MACHINE:

A drill or drill motor is a tool fitted with a cutting tool attachment or driving tool attachment, usually a drill bit or driver bit, used for drilling holes in various materials or fastening various materials together with the use of fasteners. The attachment is gripped by a chuck at one end of the drill and rotated while pressed against the target material. The tip, and sometimes edges, of the cutting tool does the work of cutting into the target material. This may be slicing off thin shavings (twist drills or auger bits), grinding off small particles (oil drilling), crushing and removing pieces of the work piece (SDS masonry drill), countersinking, counter boring, or other operations. Drills are commonly used in woodworking, metalworking, construction and do-it yourself projects. Specially designed drills are also used in medicine, space missions and other applications.

BORING MACHINE:

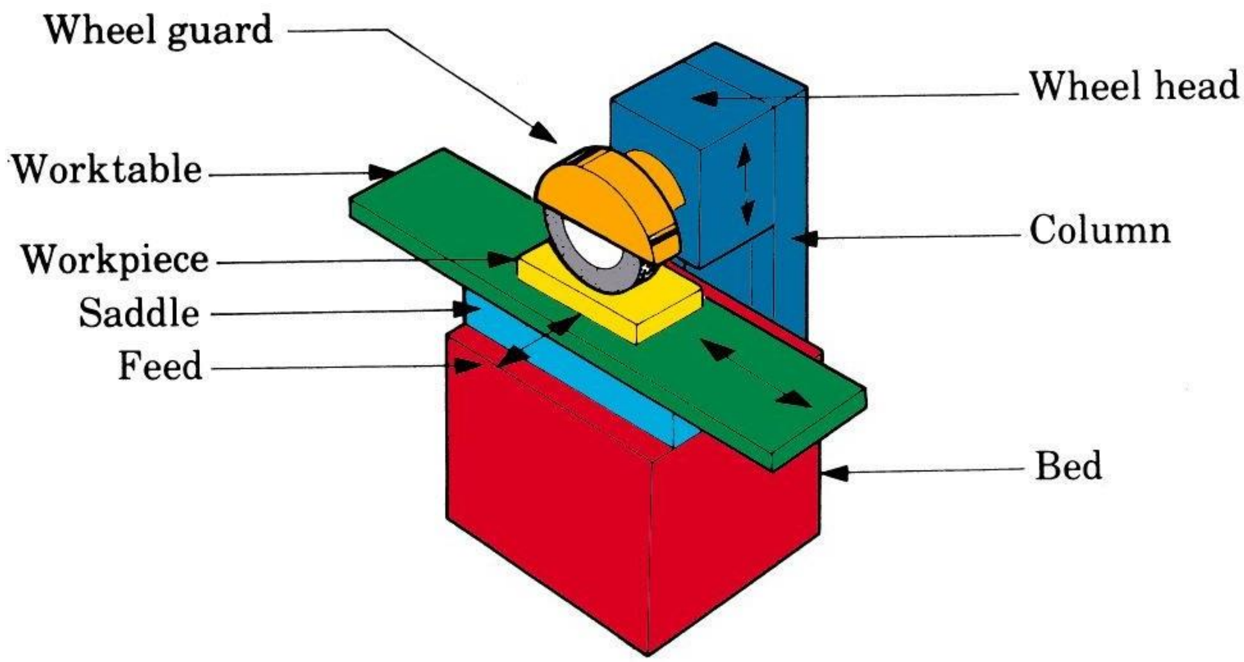
In machining, boring is the process of enlarging a hole that has already been drilled (or cast), by means of a single-point cutting tool (or of a boring head containing several such tools), for example as in boring a cannon barrel. Boring is used to achieve greater accuracy of the diameter of a hole, and can be used to cut a tapered hole. There are various types of boring. The boring bar may be supported on both ends (which only works if the existing hole is a through hole), or it may be supported at one end. Line boring (line boring, line-boring) implies the former. Back boring (back boring) is the process of reaching through an existing hole and then boring on the "back" side of the work piece (relative to the machine headstock).

MILLING MACHINE:



A milling machine (also see synonyms below) is a machine tool used to machine solid materials. Milling machines are often classed in two basic forms, horizontal and vertical, which refer to the orientation of the main spindle. Both types range in size from small, bench-mounted devices to room-sized machines. Unlike a drill press, this holds the work piece stationary as the drill moves axially to penetrate the material, milling machines also move the work piece radially against the rotating milling cutter, which cuts on its sides as well as its tip. Work piece and cutter movement are precisely controlled to less than 0.001 in (0.025 mm), usually by means of precision ground slides and lead screws or analogous technology. Milling machines may be manually operated, mechanically automated, or digitally automated via computer numerical Control (CNC).Milling machines can perform a vast number of operations, from simple (e.g., slot and keyway cutting, planing, drilling) to complex (e.g., contouring, die sinking). Cutting fluid is often pumped to the cutting site to cool and lubricate the cut and to wash away there cutting scrap.

GRINDING MACHINE:



A grinding machine, often shortened to grinder, is a machine tool used for grinding, which is a type of machining using an abrasive wheel as the cutting tool. Each grain of abrasive on the wheel's surface cuts a small chip from the work piece via shear deformation. The grinding machine consists of a power driven grinding wheel spinning at the required speed (which is determined by the wheel's diameter and manufacturer's rating, usually by a formula) and a bed with a fixture to guide and hold the work piece. The grinding head can be controlled to travel across a fixed work piece or the work piece can be moved whilst the grind head stays in a fixed position. Very fine control of the grinding head or table position is possible using a Vernier calibrated hand wheel, or using the features of numerical controls.

PERFORM THE PART SHOWN IN THE SKETCH FROM A MILD STEEL ROD ON A LATHE.

AIM:

To perform lathe operations step turning and Taper turning operation by Compound Rest Swiveling method on the given cylindrical work piece.

MATERIALS REQUIRED:

Mild Steel round rod of diameter 25 mm.

TOOLS AND EQUIPMENT USED:

H.S.S. single point cutting tool,

Parting tool,

Chuckey,

Tool post key,

Outside caliper,

Steel rule.

PRINCIPLE:

Cutting Tapers on a lathe is common application. A number of methods are available for cutting tapers on a lathe.

They are:

1. Compound rest Swiveling Method.
2. Using form tools.
3. Tail stock offset method.
4. Taper attachment method.

These methods are used for turning steep and short tapers. This is a circular base graduated in degrees which can be swiveled at any angle from the center line of the lathe centers. The amount of taper in a work piece is usually specified by the ratio of the difference in diameters of the taper to its length. This is termed as conicity and is designated by the letter K.

Conicity

$$K = (D-d)/ (2x\mathit{l})$$

Referring to the above figure BC draw parallel to the axis and in the right angle Triangle ABC.

OPERATION CHART:

SEQUENCE OF OPERATIONS CUTTING TOOL USED

1. Facing H.S.S Single Point tool
2. Rough turning H.S.S Single Point tool
3. Finish turning H.S.S Single Point tool
4. Chamfering H.S.S Single Point tool

TYPES OF OPERATION:

Facing Operation

Facing is the operation of machining the ends of a piece of work to produce a flat surface square with the axis. The operation involves feeding the tool perpendicular to the axis of rotation of the work piece.

A regular turning tool may be used for facing a large work piece. The cutting edge should be set at the same height as the center of the work piece. The tool is brought into work piece from around the center for the desired depth of cut and then is fed outward, generally by hand perpendicular to the axis of rotation of the work piece.

Rough Turning Operation

Rough turning is the operation of removal of excess material from the work piece in a minimum time by applying high rate of feed and heavy depth of cut. The depth of cut for roughing operations in machining the work ranges from 2 to 5 mm and the rate of feed is from

to 1.5 mm per revolution of the work.

Finish Turning Operation

It requires high cutting speed, small feed, and a very small depth of cut to generate a smooth surface. The depth of cut ranges from 0.5 to 1 mm and feed from 0.1 to 0.3 mm per revolution of the work piece.

Step Turning

Is the operation of making different diameters of desired length. The diameters and lengths are measured by means of outside caliper and steel rule respectively.

Taper Turning

A taper may be defined as a uniform increase or decrease in diameter of a piece of work measured along its length. In a lathe, taper turning means to produce a conical surface by gradual reduction in diameter from a cylindrical work piece. The amount of taper in a work piece is usually specified by the ratio of the difference in diameters of the taper to its length. This is termed as the conicity

PROCEDURE:

1. The work piece is fixed in the tool post tightly and the center of head stock and tail stock is coincided with the centers of head stock and tail stock.
2. Facing and plain turning operations are performed to get the required diameter on the work piece.
3. Step turning operation is performed to get the required diameters of the steps on the work piece.
4. The compound rest is set on the required half taper angle and is locked by the cutting rod is adjusted to a fixed position for the best possible to the open hand wheel and cross feed.
5. Then the compound rest is swiveled by calculated half taper angle and taper is generated on the work piece. Rotation of the compound slide screw will cause the tool to be fed at the half-taper angle.
6. Then the carriage is locked and first cut is made at the end of the cut, the tool is again cross fed is given for the next cut.
7. Cuts are repeated piece is then removed from the chuck and dimensions obtained are noted.

PRECAUTIONS:

1. Operate the machine at optimal speeds
2. The work piece should be fixed tight in the jaw.
3. Do not take depth of cut more than 2 mm.
4. Don’t leave the chuck key in the chuck.
5. Don’t place the tools and instruments nearer to the running parts.
6. The power supply switched off before measuring diameters.

RESULT:

The required steps taper are made on the work piece for the given dimensions.

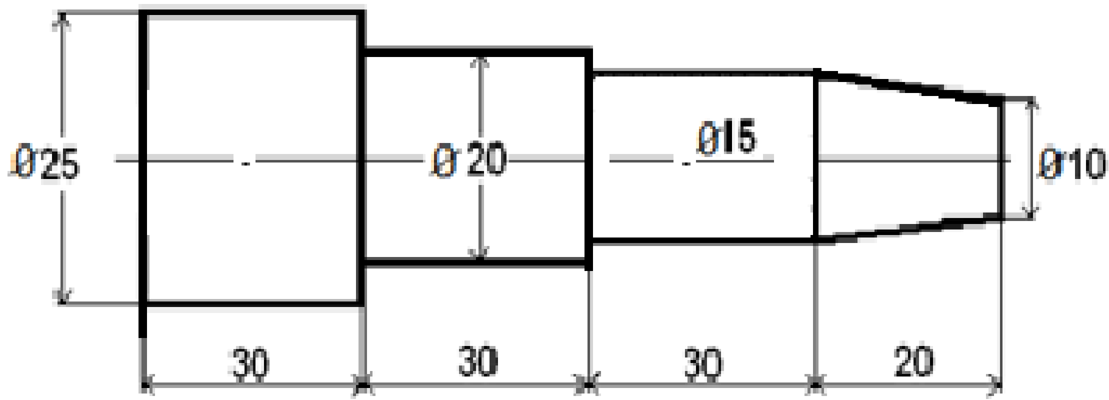


Fig. STEP TURNING AND TAPER TURNING

DRILLING AND TAPPING ON RADIAL DRILLING MACHINE

AIM:

To perform drilling, reaming and tapping operations on the given M.S Flat work piece.

APPARATUS:

1. Drilling Machine with standard accessories
2. Work piece

MATERIAL REQUIRED:
Mild Steel plate of 50 x 50 x 12 mm.

PROCEDURE:

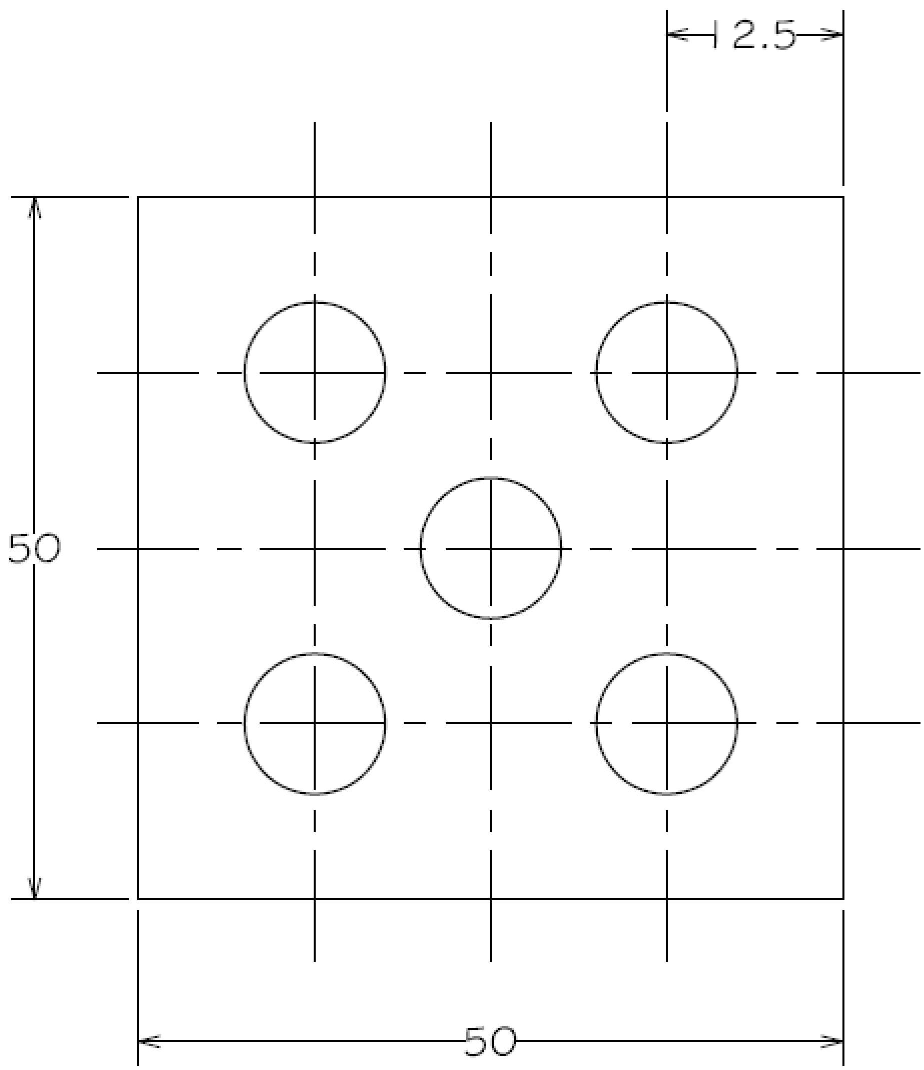
1. The given work piece is first fitted to get required length, breadth and thickness wet chalk is applied on four sides and with the scriber lines are drawn to get center hole at required location.
2. The centers are punched with a Punch and hammer.
3. The work piece is fixed firmly in the vice of the Drilling Machine
4. 3/8" drill bit is fixed firmly in the chuck and drilling is performed giving uniform depths.
5. The drill bit is removed from the drill chuck and is replaced by a reamer.
6. The reaming operation is performed on the hole which has been previously drilled.
7. The work is removed from the vice for performing tapping operation.
8. The job is fixed firmly in a bench vice.
9. Tap is fixed in the tap handle and pressure applied on the taps to obtain internal thread.

PRECAUTIONS:

- While performing reaming and tapping operations lubricant should be used to minimize friction.

RESULT:

Drilling, Reaming and Tapping operations are performed on the given work piece as per given dimensions.



DRILLING AND TAPING OPERATION

PERFORM THE MACHINING OF HEXAGONAL SHAPE SHOWN IN THE SKETCH ON THE SPECIMEN.

AIM:

To perform shaping operation of given mild steel rod.

MATERIAL REQUIRED:

A Mild steel rod of 25 mm diameter and 100 mm length.

MACHINNE REQUIRED:

Shaper machine

CUTTING TOOLS:

H.S.S.Tool bit of the required slot size.

SEQUENCE OF OPERATIONS:

1. Fix the specimen in the machine vice
2. By giving the required feed and depth of cut, the required slot is being
3. Made progressively.

PROCEDURE:

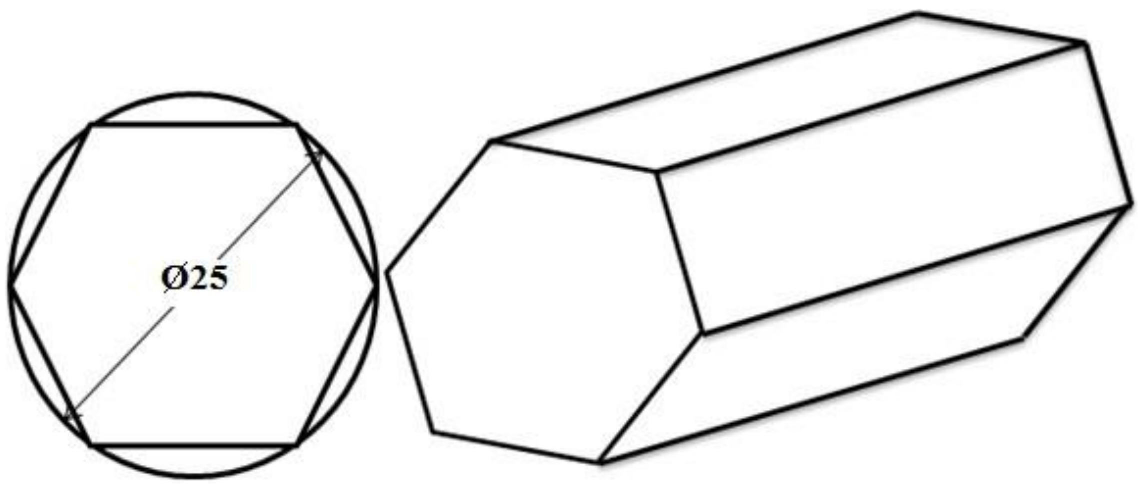
1. Dimension of the work piece is measured and made to the required dimensions by applying chalk at the end of work piece.
2. Fix the job in vice and adjust the tool in the tool head.
3. Start the machine during forward stroke only remove the material and during the return stroke is idle.
4. Do the operations to get one side completely flat then repeat the process on six sides of the work piece.
5. Rotate the job after completion of each side is flat.
6. Then check the flatness by using slip gauges. To get the required component.

PRECAUTIONS:

1. Choose proper feed and depth of cut.
2. Feed should be controlle4d to avoid to any damage to the cutting tool.
3. Fix the work piece is properly into the vice.
4. During cutting to supply coolant in between to the work piece and tool.
5. Adjust the stroke length is properly.

RESULT:

Required work piece obtained according to the specified dimensions by using shaping machine.



ROUND TO HEXAGON ON SHAPER MACHINE

PERFORM THE MACHINING A KEYWAY BY USING SLOTTING MACHINE

AIM:

To perform a slotting operation on the given work piece.

MATERIALS REQUIRED:

Mild steel, Aluminum.

MACHINE REQUIRED:

Slotting machine

CUTTING TOOLS:

H.S.S.Tool bit of the required slot size.

SEQUENCE OF OPERATIONS:

1 .Fix the specimen in the three-jaw chuck of the slotting machine

2 .By giving the required feed and depth of cut, the required slot is being Made progressively

PROCEDURE:

1. Fix the given work piece in the work holding dive available in the slotting machine firmly.
2. Fix the single point cutting tool in the tool holding dive available in the slotting machine.
3. Turn on the machine and give feed slowly to cut the required shape and size.
4. Slowly cross and longitudinal feed is given to obtain slots as per requirement.

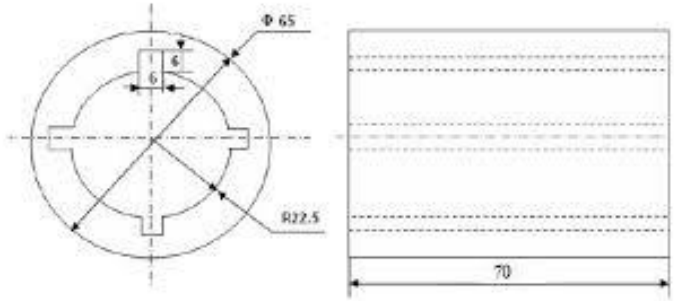
PRECAUTIONS:

1. Choose proper feed and depth of cut.
2. Feed should be controlled to avoid any damage to the cutting tool
3. Lock the index table before starting the operation.
4. Care has to be taken so as to maintain the right feed of the material.
5. Work-wheel interface zone is to be flooded with coolant

RESULT:

Required specimen obtained according to specified Operations with given dimensions

REQUIRED WORK PIECE



PERFORM THE GEAR CUTTING USING MILLING MACHINES

AIM:

To perform plane milling operation on the given specimen (mild steel) & to cut the gear tooth.

MATERIALS REQUIRED:

Mild steel specimen.

MACHINE REQUIRED:

Milling machine

TOOL REQUIRED:

Milling cutter

SEQUENCE OF OPERATIONS:

i. Measuring of specimen

ii. Fixing of specimen in the milling m/c.

iii. Giving the correct depth and automatic feed cut the specimen

PROCEDURE:

1. The dimensions of the given rod are checked with the steel rule.
2. The given rod is fixed in the vice provided on the machine table such a, one End of it is projected outside the jaws of the vice.
3. A face milling cutter is mounted on the horizontal milling machine spindle And one end of the rod is face milled, by raising the table so that the end of the rod faces the cutter.
4. The rod is removed from the vice and fitted in the reverse position.
5. The other end of rod is face milled such that, the length of the job is exactly 100 mm.
6. The table is lowered and the rod is removed from the vice and refitted in it Such that, the top face of the rod is projected from the vice jaws.

7. The face milling cutter is removed from the spindle and the arbor is mounted in the spindle; followed by fixing the plain milling cutter.
8. The top surface of the job is slab milled; first giving rough cuts followed by a finish cut.
9. The job is removed from the vice and refitted in it such that, the face opposite to the above, comes to the top and projects above the vice jaws.
10. The top surface of the job is milled in stages; giving finish cuts towards the end such that, the height of the job is exactly 40 mm.
11. The burrs if any along the edges are removed with the help of the flat file.

PRECAUTIONS:

1. The milling machine must be stopped before setting up or removing a work Piece, cutter or other accessory
2. Never stop the feeding of job when the cutting operation is going on, Otherwise the tool will cut deeper at the point where feed is stopped.
3. All the chips should be removed from the cutter. A wiping cloth should be Placed on the cutter to protect the hands.
4. The cutter should be rotated in the clockwise direction only for right handed Tools.
5. The work piece and cutter should be kept as cool as possible (i.e. coolant Should be used where necessary to minimize heat absorption).
6. The table surface should be protected with a wiping cloth.
7. Tool must be mounted as close to the machine spindle as possible.

RESULT:

Thus the spur gear made is according to the requirements in the given material.

Fig. GEAR CUTTING ON MILLING MACHINE

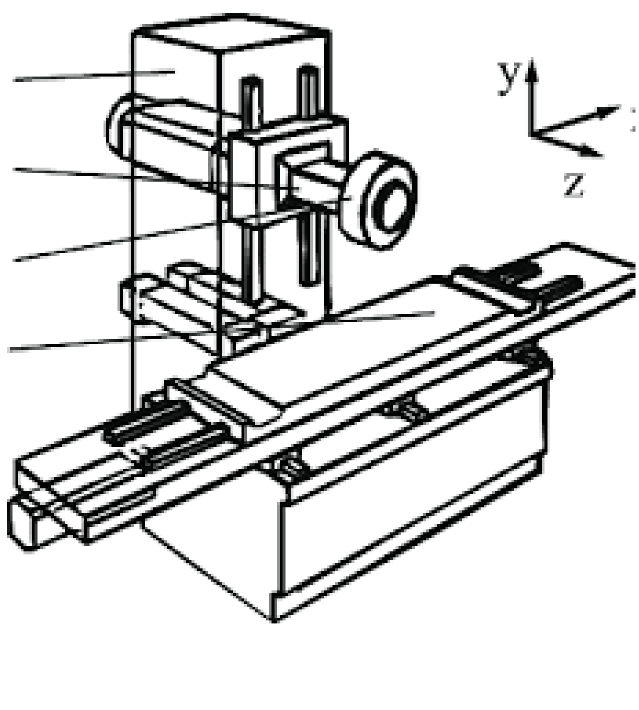
PERFORM THE AND CHECK THE DIMENSIONS OF THE SAMPLE BY SURFACE GRINDING

AIM:
Finishing of a surface on surface –grinding machine.

APPARATUS REQUIRED:
Steel rule Try square, Vernier caliper

THEORY: Surface grinding machines are useful to produce and finish flat and plane surface. Types of grinding machines: Transverse grinding, Plunger grinding.

PROCEDURE:
1.The given work piece is taken and checked for its dimensions.
2. The job is placed on the grinding magnet at opened position.
3. Then each face is grinded to the required accuracy by constant speed.
4. The job is removed from the required accuracy.
5. It is checked by using vernier caliper and squareness is checked by using try square.



Result:
Thus the square section is grinded to the required accuracy in grinding machine.

GENERAL INSTRUCTIONS

1. Students should wear the uniform and closed foot wear. Students inappropriately dressed for lab, at the instructor's discretion, are denied access.
2. Eating and drinking are prohibited in the laboratory at all times.
3. Never work in the laboratory without proper supervision by an instructor.
4. Never carry out unauthorized experiments. Come to the laboratory prepared. If you are unsure about what to do, please ask the instructor.
5. Except the scientific calculator, any other electronic devices are not permitted to use inside the Laboratory.
6. Any damage to any of the equipment/instrument/machine caused due to carelessness, the cost will be fully recovered from the individual (or) group of students.

1. METROLOGY

1.1 INTRODUCTION: Metrology is a science of measurement. Metrology may be divided depending upon the quantity under consideration into: metrology of length, metrology of time etc. Depending upon the field of application it is divided into industrial metrology, medical metrology etc. Engineering metrology is restricted to the measurement of length, angles and other quantities which are expressed in linear or angular terms. For every kind of quantity measured, there must be a unit to measure it. This will enable the quantity to be measured in number of that unit. Further, in order that this unit is followed by all; there must be a universal standard and the various units for various parameters of importance must be standardized. It is also necessary to see whether the result is given with sufficient correctness and accuracy for a particular need or not. This will depend on the method of measurement, measuring devices used etc.

Thus, in a broader sense metrology is not limited to length and angle measurement but also concerned with numerous problems theoretical as well as practical related with measurement such as:

1. Units of measurement and their standards, which is concerned with the establishment, reproduction, conservation and transfer of units of measurement and their standards.
2. Methods of measurement based on agreed units and standards.
3. Errors of measurement.
4. Measuring instruments and devices.
5. Accuracy of measuring instruments and their care.
6. Industrial inspection and its various techniques.
7. Design, manufacturing and testing of gauges of all kinds.

1.2 NEED OF INSPECTION: Inspection means checking of all materials, products or component parts at various stages during manufacturing. It is the act of comparing materials, products or components with some established standard. In old days the production was on a small scale, different component parts were made and assembled by the same craftsman. If the parts did not fit properly at the time of assembly, he used to make the necessary adjustments in either of the mating parts so that each assembly functioned properly. Therefore, it was not necessary to make similar parts exactly alike or with same accuracy as there was no need of inspection. Due to technological development new production techniques have been developed. The products are being manufactured on a large scale due to low cost methods of mass production. So, hand fit method cannot serve the purpose any more. The modern industrial mass production system is based on interchangeable manufacture, when the articles are to be produced on a large scale. In mass production the production of complete article is broken up into various component parts. Thus the production of each component part becomes an independent process. The different component parts are made in large quantities in different shops. Some parts are purchased from other factories also and then assembled together at one place. Therefore, it becomes essential that any part chosen at random should fit properly with any other mating parts that too selected at random. This is possible only when the dimensions of the component parts are made with close dimensional tolerances. This is only possible when the parts are inspected at various stages during manufacturing. When largenumber of identical parts are manufactured on the basis of interchangeability if their dimensions are actually measured every time lot of time will be required.Hence, to save the time gauges are used, which can tell whether the part manufactured is within the prescribed limits or not.

Thus, the need of inspection can be summarized as:

1. To ensure that the part, material or a component conforms to the established standard.
2. To meet the interchangeability of manufacture.
3. To maintain customer relation by ensuring that no faulty product reaches the customers.
4. Provide the means of finding out shortcomings in manufacture. The results of inspection are not only recorded but forwarded to the manufacturing department for taking necessary steps, so as to produce acceptable parts and reduce scrap.
5. It also helps to purchase good quality of raw materials, tools, equipment which governs the quality of the finished products.
6. It also helps to co-ordinate the functions of quality control, production, purchasing and other departments of the organization. To take decision on the defective parts i.e., to judge the possibility of making some of these parts acceptable after minor repairs.

1.3 OBJECTIVES OF METROLOGY: While the basic objective of a measurement is to provide the required accuracy at minimum cost, metrology would have further objective in a modern engineering plant with different shops like Tool Room, Machine Shop, Press Shop, Plastic Shop, Pressure Die Casting Shop, Electroplating and Painting Shop, and Assembly Shop; as also Research, Development and Engineering Department. In such an engineering organization, the further objectives would be as follows:

1. Thorough evaluation of newly developed products, to ensure that components designed is within the process and measuring instrument capabilities available in the plant.
2. To determine the process capabilities and ensure that these are better than the relevant component tolerance.
3. To determine the measuring instrument capabilities and ensure that these are adequate for their respective measurements.
4. To minimize the cost of inspection by effective and efficient use of available facilities and to reduce the cost of rejects and rework through application of Statistical Quality Control Techniques.
5. Standardization of measuring methods. This is achieved by laying down inspection methods for any product right at the time when production technology is prepared.
6. Maintenance of the accuracies of measurement. This is achieved by periodical calibration of the metrological instruments used in the plant.
7. Arbitration and solution of problems arising on the shop floor regarding methods of measurement.
8. Preparation of designs for all gauges and special inspection fixtures.

1.4 LINEAR MEASUREMENT: It applies to measurement of lengths, diameters, heights, and thickness including external and internal measurements. The line measuring instruments haveseries of accurately spaced lines marked on them, e.g. scale. The dimension to be measured is aligned with the graduations of the scale. Linear measuring instruments are designed either for line instruments, the measurement is taken between two end surfaces as in micrometers, slip gauges etc. The instruments used for linear measurements can be classified as:

1. Direct measuring instruments
2. Indirect measuring instruments

The direct measuring instruments are of two types:

1. Graduated
2. Non Graduated

The graduated instruments include rules, vernier calipers, vernier height gauges, vernier depth gauges, micrometers, dial indicators etc.

The non-graduated instruments include calipers, trammels, telescopic gauges, surface gauges, straight gauges, wire gauges, screw pitch gauges, thickness gauges, slip gauges etc. They can also be classified as:

1. Non-precision instruments such as steel rule, calipers etc.
2. Precision measuring instruments, such as vernier instruments, micrometers, dial gauges etc.

1.5ANGULAR MEASUREMENT: These are frequently necessary for the manufacture of interchangeable parts. The ships and aero planes can navigate confidently without the help of the site of the land; only because of precise angular measuring devices can be used in astronomy to determine the relation of the stars and their approximate distances. The angle is defined as the opening between two lines which meet at a point. If one of the two lines is moved at a point in an arc, a complete circle can be formed. The basic unit in angular measurement is the right angle, which is defined as the angle between two lines which intersect so as to make the adjacent angles equal. If a circle is divided into 360 equal parts. Each part is called as degree (0). Each degree is divided in 60 minutes (‘), and each minute is divided into 60 seconds (“). This method of defining angular units is known as sexagesimal system, which is used for engineering purposes. An alternative method of defining angle is based on the relationship between the radius and arc of a circle. It is called as radian. Radian is defined as the angle subtended at the centre by an arc of a circle of length equal to its radius. It is more widely used in mathematical investigation. 2 radians = 360, giving, 1 radian = 57.2958 degrees. In addition linear units such as 1 in 30 or millimeters per meter are often used for specifying tapers and departures from squareness or parallelism.

1.6. INTRODUCTION ABOUT INSTRUMENTS:

(1) VERNIER CALIPER: Vernier Calipers is the most commonly used instrument for measuring outer and inner dimensions. It works on the principle of Vernier Scale which is some fixed units of length (Ex: 49mm) divided into 1 less or 1 more parts of the unit (Ex: 49mm are divided into 50

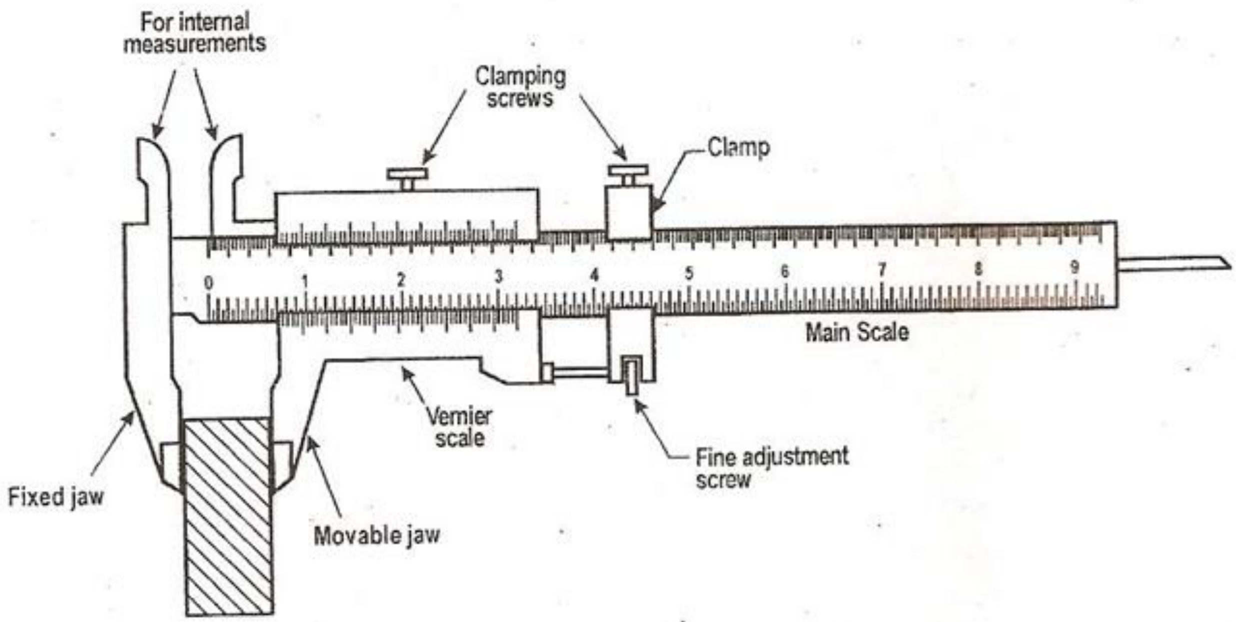


FIGURE 1: VERNIER CALIPER

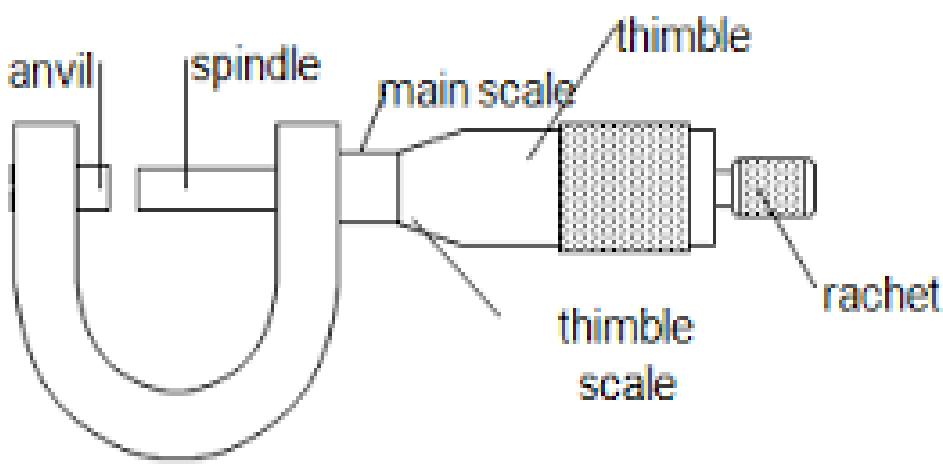


FIGURE 2: MICROMETER

parts). The exact measurement with up to 0.02mm accuracy can be determined by the coinciding line between Main Scale and Vernier Scale.

Total Reading = M.S.R + L.C * V.S.R

Where:

M.S.R – Main Scale Reading

L.C – Least Count

V.S.R – Vernier Scale Reading

Uses: It is used to measure the external diameter, internal diameter and the length of the specimen.

(2) MICROMETER: Micrometer is one of the most common and most popular forms of measuring instrument for precise measurement with 0.01mm accuracy. It works on the principle of screw and nut. We know that when a screw is rotated through one revolution it advances by one pitch distance i.e. one rotation of screw corresponding to a linear movement of a distance equal to pitch of the screw thread.

Total Reading = M.S.R + L.C * T.S.R

Where:

M.S.R – Main Scale Reading

L.C – Least Count

T.S.R –Thimble Scale Reading

Uses: Outside micrometer is used to measure the diameter of solid cylinder. Inside micrometer is used to measure the internal diameters of hollow cylinders.

(3) GEAR TOOTH VERNIER: It is used to measure the thickness of gear teeth at the pitch line or chordal thickness of teeth and the distance from the top of a tooth to the chord. The thickness of a tooth at pitch line and the addendum is measured by an adjustable tongue, each of which is adjusted independently by adjusting screw on graduated bars. The effect of zero errors should be taken into consideration. This method is simple and inexpensive. However it needs different setting for a variation in number of teeth for a given pitch and accuracy is limited by the least count of instrument. Since the wear during use is concentrated on the two jaws, the calliper has to be calibrated at regular intervals to maintain the accuracy of measurement.

Tooth thickness is the arc distance measured along the pitch circle from its intercept with one flank to its intercept with the other flank of the tooth. Addendum is the radial distance from the tip of a tooth to the pitch circle. In the most of the cases, it is sufficient to measure the chordal thickness i.e. the chord joining the intersection of the tooth profile with the pitch circle because it is difficult to measure length of the arc directly.

Uses:To measure the chordal thickness of a gear tooth on the pitch circleand the distance from the top of the tooth to the pitch chord (chordaladdendum) at the same time.

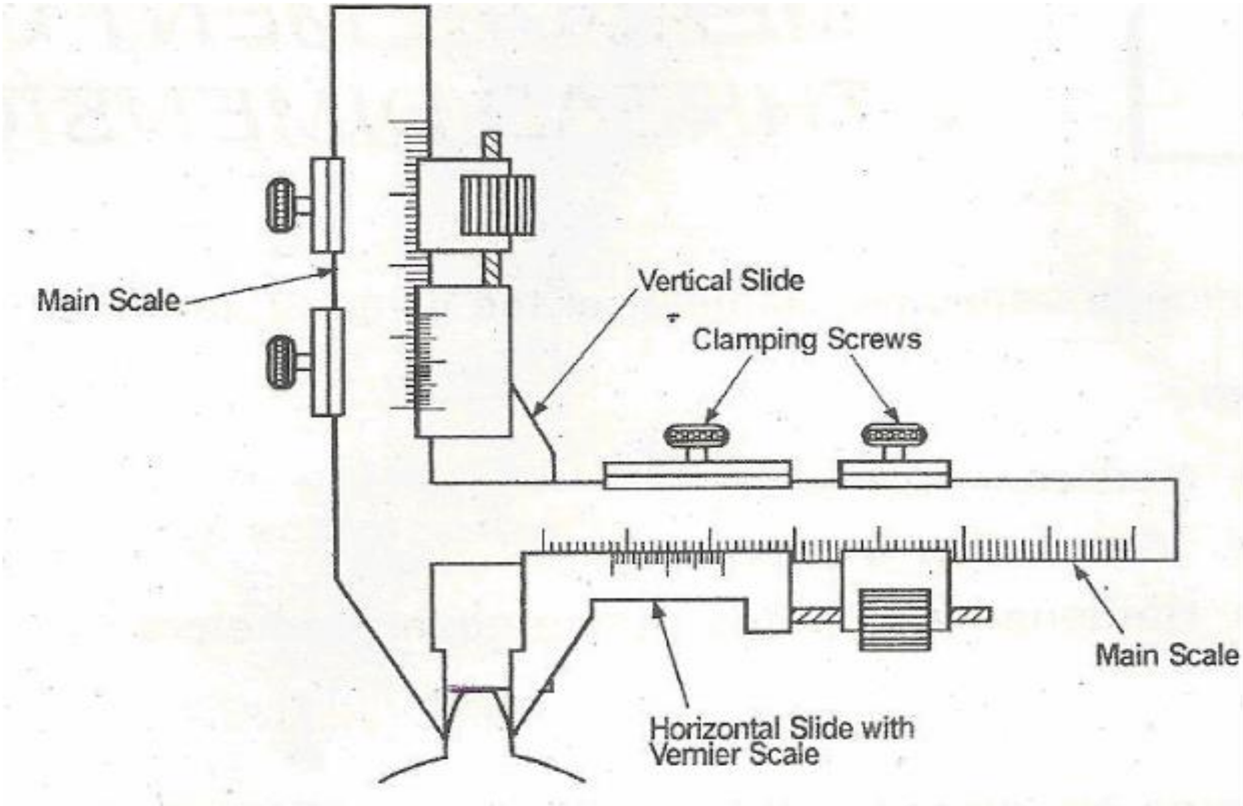


FIGURE 3: GEAR TOOTH VERNIER

(4) BEVEL PROTRACTOR: It is probably the simplest instrument for measuring the angle between two faces of component. It consists of a base plate attached to the main body, and an adjustable blade which is attached to a circular plate containing vernier scale. The adjustable blade

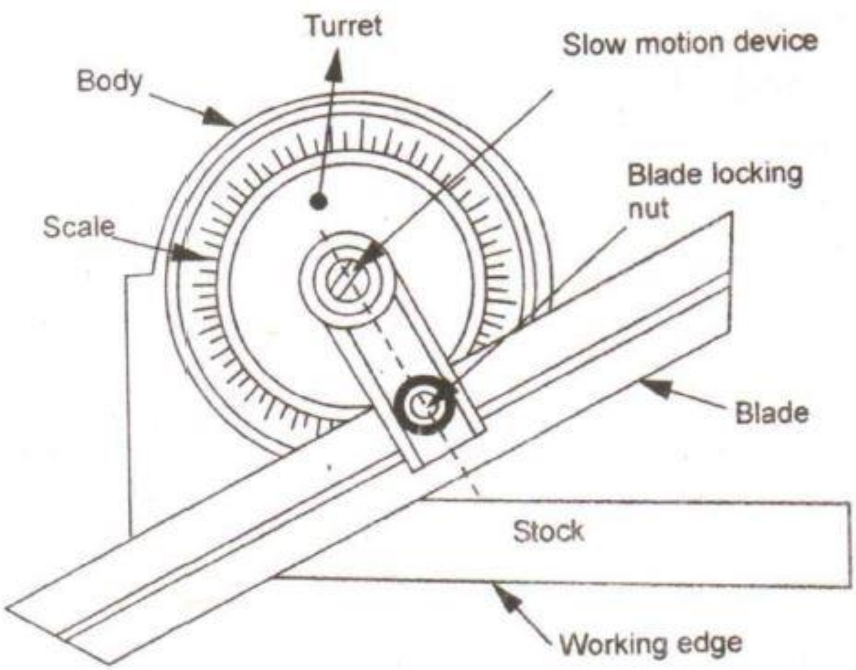


FIGURE 4: VERNIER BEVEL PROTRACTOR

is capable of rotating freely about the centre of the main scale engraved on the body of the instrument and can be locked in any position. An acute angle attachment is provided at the top for the purpose of measuring acute angles. The base of the base plate is made flat so that it could be laid flat upon the work and any type of angle measured. It is capable of measurement from 0^0 to $360^{0.}$ The vernier scale has 24 divisions coinciding with 23 main scale divisions. Thus the least count of the instrument is 5'. This instrument is most commonly used in workshops for angular measurements till more precision is required.

Uses:

1. It is used to measure acute angles accurately.
2. It is used to establish and test angles to very close tolerances.
3. It is most commonly usedin workshops for angular measurementstill more precision is required.

(5) SINE BAR: The sine principle uses the ratio of the length of two sides of a right triangle in deriving a given angle. It may be noted that devices operating on sine principle are capable of "self generation." The measurement is usually limited to 45^0 from loss of accuracy point of view. The accuracy with which the sine principle can be put to use is dependent in practice, on some form of linear measurement. The sine bar in itself is not a complete measuring instrument. Another datum such as a surface plate is needed, as well as other auxiliary equipment, notably slip gauges, and indicating device to make measurements. Sine bars used in conjunction with slip gauges constitute a very good device for the precise measurement of angles. Sine bars are used either to measure angles very accurately or for locating any work to a given angle within very close limits. Sine bars are made from high carbon, high chromium, corrosion resistant steel, hardened, ground and stabilized.

Uses:

1. Measuring known angles or locating any work to a given angle.
2. Checking of unknown angles.
3. Checking of unknown angles of heavy component.

(6)SLIP GAUGES: Slip gauges or gauge blocks are universally accepted end standard of length in industry. These were introduced by Johnson, a Swedish engineer, and are also called as johanson gauges. Slip gauges are rectangular blocks of high grade steel with exceptionally close tolerances. These blocks are suitably hardened through out to ensure maximum resistance to wear. They are then stabilized by heating and cooling successively in stages so that hardening stresses are removed, After being hardened they are carefully finished by high grade lapping to a high degree of finish, flatness and accuracy. For successful use of slip gauges their working faces are made truly flat and parallel. Slip gauges are also made from tungsten carbide which is extremely hard and wear resistance. The cross-sections of these gauges are 9 mm x 30 mm for sizes up to 10 mm and 9 mm x 35 mm for larger sizes. Any two slips when perfectly clean may be wrung together. The dimensions are permanently marked on one of the measuring faces of gauge blocks.

Uses:

1. Direct precise measurement, where the accuracy of the work piece demands it.

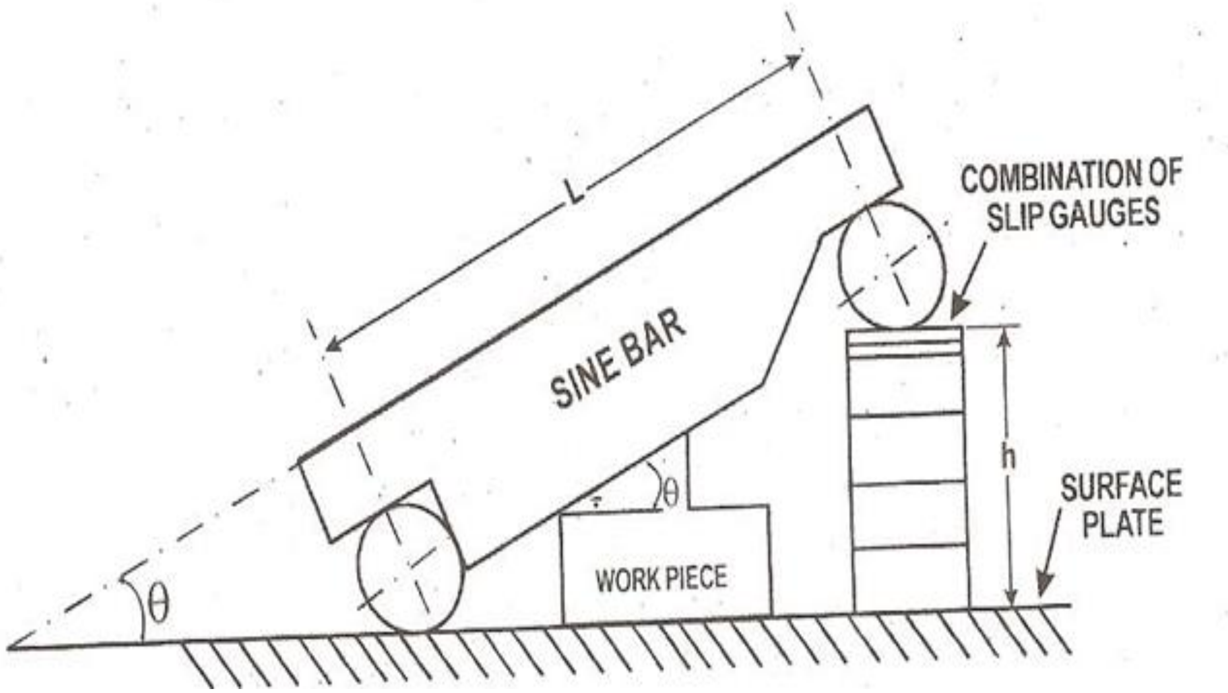


FIGURE 5: SINEBAR

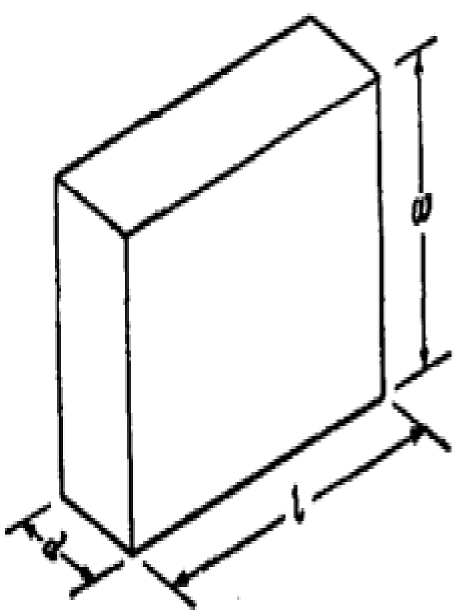


FIGURE 6: SLIP GAUGE

2. For checking accuracy of verniercallipers, micrometers, and such other measuring instruments. 3. Setting up a comparator to a specific dimension.
4. For measuring angle of work piece and also for angular setting in conjunction with a sine bar.
5. The distances of plugs, spigots, etc. on fixture are often best measured with the slip gauges or end bars for large dimensions.
6. To check gap between parallel locations such as in gap gauges or between two mating parts.

(7) DIAL INDICATOR: Dial indicators are small indicating devices using mechanical means such as gears and pinions or levers for magnification system. They are basically used for making and checking linear measurements. Many a times they are also used as comparators. Dial indicator, in fact is a simple type of mechanical comparator. When a dial indicator is used as an essential part in the mechanism any set up for comparison measurement purposes; it is called as a gauge. The dial indicator measures the displacement of its plunger or a stylus on a circular dial by means of a rotating pointer. Dial indicators are very sensitive and versatile instruments. They require little skill in their use than other precision instruments, such as micrometer verniercallipers, gauges etc. However, a dial indicator by itself is not of much unless it is properly mounted and set before using for inspection purposes.

Uses: By mounting a dial indicator on any suitable base and with various attachments, it can be used for variety of purposes as follows:

1. Determining errors in geometrical forms, e.g., ovality out-of-roundness, taper etc.
2. Determining positional errors of surfaces, e.g., in squareness, parallelism, alignment etc.
3. Comparing two heights or distances between narrow limits (comparator).

The practical applications of the use of dial indicator are:

1. To check alignment of lathe centers by using a suitable accurate bar between centers.
2. To check trueness of milling machine arbors.
3. To check parallelism of the shaper ram with table surface or like.

(8) TOOL MAKER’S MICROSCOPE: InTool maker’s microscope the optical head can be moved up or down the vertical column and can be clamped at any height by means of clamping screw. The table which is mounted on the base of the instrument can be moved in two mutually perpendicular horizontal directions (longitudinal and lateral) by means of accurate micrometer screw having thimble scale and veniers.

A ray of light from a light source is reflected by a mirror through 90’ It then passes through a transparent glass plate (on which flat parts may be placed). A shadow image of the outline or counter of the workspaces passes through the objective of the optical head and is projected by a system of three prisms to a ground glass screen. Observations are made through an eyepiece. Measurements are made by means of cross lines engraved on the ground glass screen. The screen can be rotated through 360^0; the angle of rotation is read through an auxiliary eyepiece.

Uses:

1. The determination of relative position of various points on work.
2. Measurement of angle by using a protractor eyepiece.

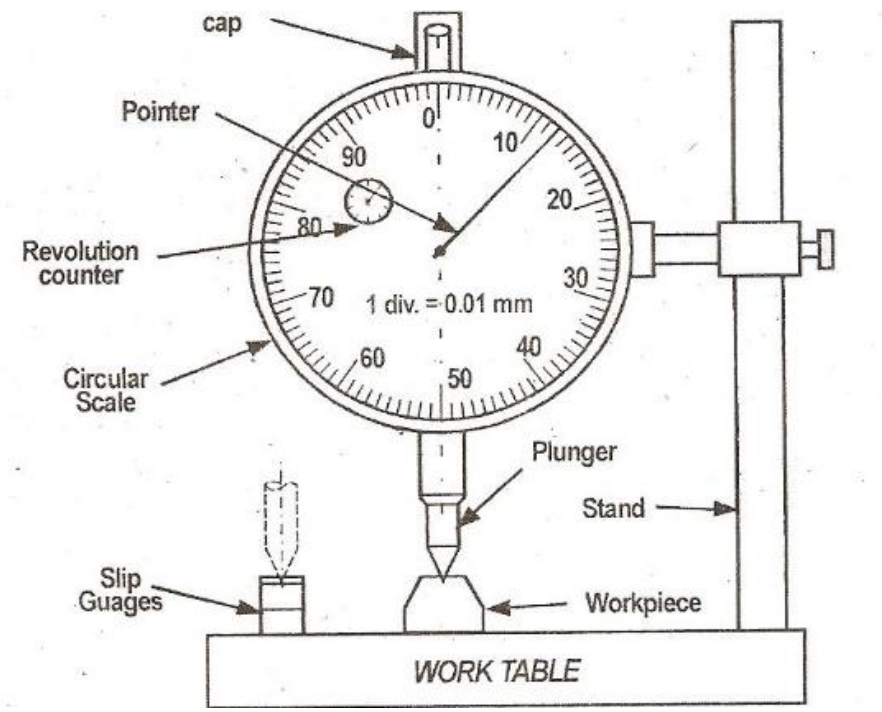


FIGURE 7: DIAL INDICATOR

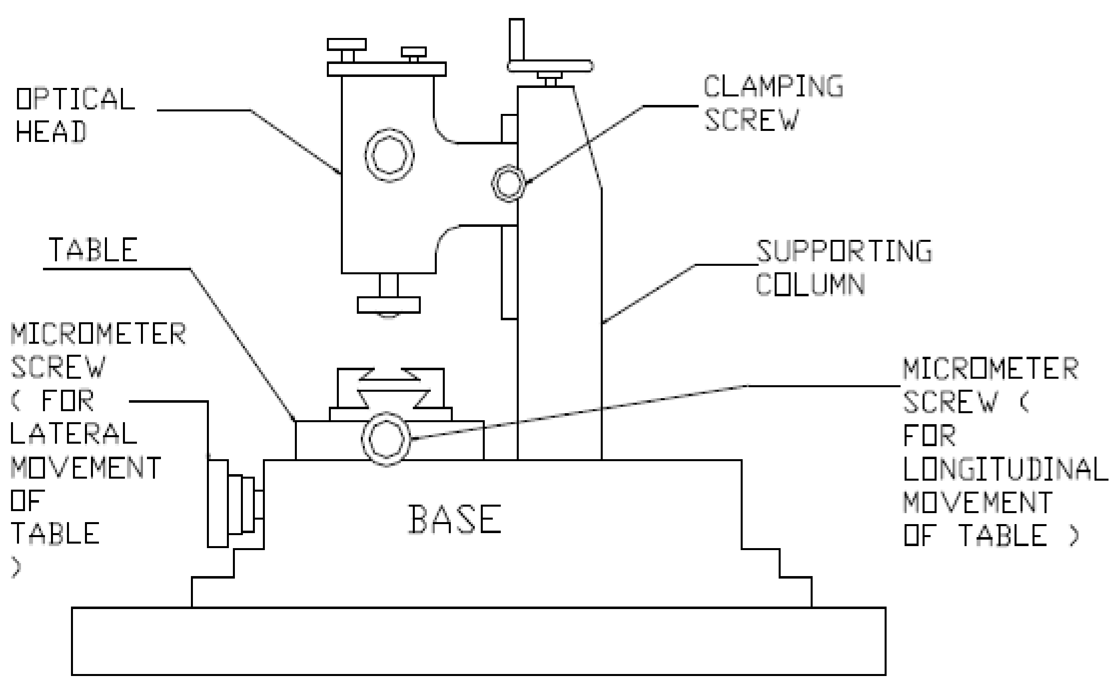


FIGURE 8: TOOL MAKER'S MICROSCOPE

3. Comparison of thread forms with master profiles engraved in the eyepiece, measurement of pitch and effective diameter.
4. Comparison of an enlarged, projected image with a tracing fixed to the projecting screen.

(9) SPIRIT LEVEL:A spirit level consists of a sealed glass tube, ground on its inside surface to a convex formwith a large radius of curvature R. A scale is engraved on the glass at the top of the tube. The tube is nearly filled with ether such that only a small volume remains at the top part of the tube whichcontains ether vapours in the form of a bubble. The glass tube is set in the base and adjusted in such a way that whenthe base is horizontal the bubble rests at the centre of the scale which is engraved on the glass.When the base of the level is moved out of the horizontal, the bubble tries to remain at thehighest point of the tube and thus moves alongthe scale.

1.7 GENERAL CARE OF METROLOGICAL EQUIPMENT: The equipment (apparatus) used for precision measurements is designed to fine limits of accuracy and is easily liable to be damaged by even-slight mishandling and such damage may not be noticeable. A great deal of careful handling is, therefore, required. As far as possible, the highly finished surfaces should not be touched by hand because the natural acids on the skin are likely to corrode the finished surface and also the temperature of body may upset the dimensions of the precision instruments. In order to overcome this many standard metrology laboratories recommend washing of hands thoroughly and coating them with a thin fily; of pure petroleum jelly before handling the instruments. Further very precise equipment like slip gauges is allowed to be handled only by using a piece of chamois leather or tongs made from a strip of "Perspex". When the equipment is not in use, it should be protected from atmospheric corrosion. For this purpose the highly finished surfaces are first wiped with a solvent to remove any finger mark and then coated with mixture of heated petroleum jelly and petrol. This mixture spreads much more easily and is applied with cloth or with fingers. Brushing is not recommended as it is liable to air which, with the moisture it contains, may cause rusting. As the standard temperature for measurement is 20°C, for very precise measurement the instruments and work pieces should be allowed to attain this temperature before use and the handling should be as little as possible.

EXPERIMENT NO: **DATE:**

Calibration of Micrometer, Mechanical Comparator, Vernier Caliper and Dial Gauge.

Aim:

To measure length and diameter using Micrometer, Mechanical Comparator, Vernier Caliper and Dial Gauge.and also to calibrate the precision measuring instruments.

Apparatus:

1. Vernier Caliper, Slip gauges,Round rod.
2. Micrometer, Slip gauges, Round rod.
3. Mechanical comparator
4. Dial gauge

Procedure to measure length and diameter using Vernier Caliper:

1. The Least Count is to be determined as L.C= 1MSD- 1VSD = 1- 49/50 =0.02mm.
2. The workpiece is placed between the jaws of Vernier Calipers correctly.
3. The reading on Main scale which is just behind the first Vernier Scale Division is noted as Main Scale Reading.
4. The Division on Vernier Scale which coincides with the line on Main Scale is noted down as Vernier Coincidence.
5. The length and diameter can be calculated using the given Formula.

Length/diameter of the work piece = Main Scale Reading + (Vernier Scale Reading*Least Count)

Procedure to measure length and diameter using Micrometer:

1. The least count is to be determined.
2. The workpiece is placed between the two anvils after the instruments are adjusted for zero error.
3. Work piece is held strongly without applying any pressure on the instrument.
4. The value of the main scale is noted down. The main scale division just coincides with the index line.
5. Take the thimble scale reading (TSR) which coincides with the reference line on the sleeve.

Length/diameter of the work piece = Main Scale Reading + (Thimble Scale Reading*Least Count)

Procedure for Calibration:

1. The range of the instruments is noted down.
2. Within that range, slip gauges are selected.
3. The measuring instrument is placed on the surface plate and set it as zero and the slip gauges are placed one by one in between the measuring points (jaws of the instruments).
4. The slip gauge readings and observed readings in the measuring instruments are to be noted in the table shown below.
5. Calculate the error and percentage error

Formula:

Error= slip gauge reading- total reading

Error percentage= [(error- total reading) / total reading] x 100

6. Plot the graph between
(i) Slip gauge reading vs Total reading (Instrument)
(ii) Slip gauge reading vs Error

Calculations:

For length measurement using vernier caliper:

S. No	MSR (mm)	VSR (div)	LC (mm)	TR=MSR+(VSR*LC) (mm)
1				
2				
3				
4				
5				
6				
7				
AVG				

For diameter measurement using vernier caliper:

S. No	MSR (mm)	VSR (div)	LC (mm)	TR=MSR+(VSR*LC) (mm)
1				
2				
3				
4				
5				
6				
7				
AVG				

Calibration:

S. No	Slip Gauge Reading (mm)	MSR (mm)	VSR (mm)	TR (mm)	Error (mm)
1					
2					
3					
4					
5					
6					
7					

Calculations:

For length measurement using micrometer:

S. No	MSR (mm)	VSR (div)	LC (mm)	TR=MSR+(VSR*LC) (mm)
1				
2				
3				
4				
5				
6				
7				
AVG				

For diameter measurement using micrometer:

S. No	MSR (mm)	VSR (div)	LC (mm)	TR=MSR+(VSR*LC) (mm)
1				
2				
3				
4				
5				
6				
7				
AVG				

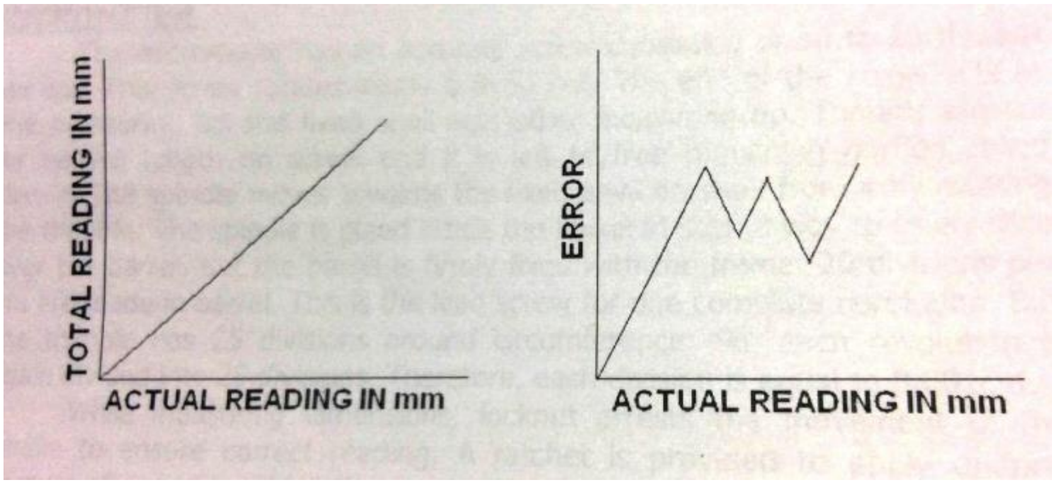
Calibration:

S. No	Slip Gauge Reading (mm)	MSR (mm)	VSR (mm)	TR (mm)	Error (mm)
1					
2					
3					
4					
5					
6					
7					

Precautions to be followed during vernier caliper reading :

1. Clean the measuring faces with paper or cloth.
2. Don’t apply pressure on jaws.
3. Make sure the workpiece axis is perpendicular to the Vernier Calipers.
4. The calipers should not be fitted or twisted.
5. Set the zero reading of the instrument to before measuring.

MODEL GRAPH



Result:

Physical quantities like length and diameter of the given specimens are measured using vernier caliperand also calibrated the precision measuring instrument.

The measured physical quantities using Vernier Caliper.
a. Length of the given specimen =
b. Diameter of the given specimen =

The precision measuring instrument is calibrated.
Error percentage of Vernier caliper =

Physical quantities like length and diameter of the given specimens are measured using micrometer and also calibrated the precision measuring instrument.

The measured physical quantities using Micrometer.
a. Length of the given specimen =
b. Diameter of the given specimen =

The precision measuring instruments are calibrated.
Error percentage of micrometer =

EXPERIMENT NO: **DATE:**

MEASUREMENT OF TAPER ANGLE USING BEVEL PROTRACTOR, DIAL GAUGE AND SINE BAR

Aim:

To measure the angle of the given workpiece using bevel protractor and sine bar.

Apparatus:

- Sine bar,
- Workpiece,
- Dial gauge,
- Slip gauges,
- Bevel protractor.

Procedure:

Sine bar

1. Place the work piece/wedge above the sine bar and make it horizontal with the base.
2. The dial gauge is then set at one end of the work moved along the upper surface of the component.
3. If there is any variation in parallelism of the upper surface of the component and the surface plate, it is indicated by the dial gauge.
4. The combination of the slip gauges is so adjusted that the upper surface is truly parallel with the surface plate.
5. Note down the values of the slip gauges.
6. Calculate the angle using $\theta=Sin^{-1}(h/L)$

   Where, θ= Taper angle in degree

   h=Height of the slip gauges in mm

   L= Length of the sine bar in mm
7. Repeat the procedure 3 or 4 times and take the average.

Bevel protractor

1. The least count is calculated by knowing the value of the smallest division on the main scale and number of division on the vernier scale.
2. To measure angle between two planes, rest the stem on one of the planes (reference plane).
3. Rotate the blade such that blade is flush with second plane.
4. Readings are taken after ensuring that the stem and blade are in flush with the two planes.
5. Lock the protractor at this point and note down the readings.

Calculations:

For sine bar

Sl. No.	HEIGHT OF SLIP GAUGE (mm)	LENGTH OF SINE BAR (mm)	ANGLE, $\theta = Sin^{-1}(h/L)$ (Deg)
1.			
2.			
3.			
4.			
AVG=			

For bevel protractor

Sl. No.	TRIAL	ANGLE OBTAINEDBY BEVEL PROTRACTOR=(90- θ)
1.		
2.		
3.		
4.		
	AVG=	

Precautions:

1. The sine bar should not be used for angle greater than 60^0 because anypossible error in construction is accentuated at this limit.
2. A compound angle should not be formed by misaligning of work piece with the sine bar. This can be avoided by attaching the sine bar and work againstan angle plate.
3. As far as possible longer sine bar should be used since using longer sine barsreduces many errors.

Result:

Thus the angle of the given specimen is measured using bevel protractor and sine bar.
Angle obtained using bevel protractor =
Angle obtained using sine bar =

EXPERIMENT NO: **DATE:**

MEASURE THE FLATNESS OF THE OBJECT USING DIAL GAUGE

Aim:

To perform alignment tests on milling machine to check the flatness.

Apparatus:

- Dial gauge,
- Test mandrel, and
- Spirit level.

Procedure:

1. Flatness of work table in longitudinal and transverse direction:

A spirit level is placed directly on the table at points about 25 to 30 cm apart, at A, B, C for longitudinal tests and D, E and F for the transverse test. Then readings are noted. Permissible error in longitudinal and transverse is ±0.04 mm.

2. True running of internal taper of main spindle:

The test mandrel is held with its taper shank in the main spindle socket. The dial gauge is mounted on the table such that its feeler touches the test mandrel.Spindle is rotated and dial gauge readings are noted at two different positions.Permissible error is 0.02 mm.

3. Parallelism of the work table surface to the main spindle:

The table is adjusted in the horizontal plane by a spirit level and is then set in its mean position longitudinally. The mandrel is fixed in the spindle taper. Dial gauge is mounted on the table such that its feeler touches the lower surface of the mandrel Readings are taken at two positions by moving the stand of the dial gauge. Permissible error is 0.02 mm.

4. Parallelism of the cross (transverse) movement of the worktable to the main spindle:

The worktable is set in its mean position. The mandrel is held in the spindle. A dial gauge fixed to the table is adjusted so that its spindle touches the surface of the mandrel. The tale is moved cross-wise and the error is measured in the vertical plane and also in the horizontal plane.Permissible error is 0.02 mm.

Calculations:

Flatness of work table in longitudinal and transverse direction (Fig-1)

Position	A	B	C
Error			

Position	D	E	F
Error			

True running of internal taper of main spindle (Fig-2)

Position 1

Point	1	2	3
Error			

Position 2

Point	1	2	3
Error			

Parallelism of the work table surface to the main spindle (Fig-3)

Position 1

Point	1	2	3
Error			

Position 2

Point	1	2	3
Error			

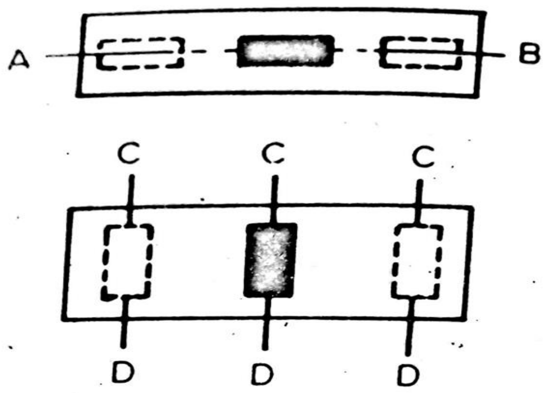
Parallelism of the cross (transverse) movement of the worktable to the main spindle (Fig-4)

Position 1

Point	1	2	3
Error			

Position 2

Point	1	2	3
Error			



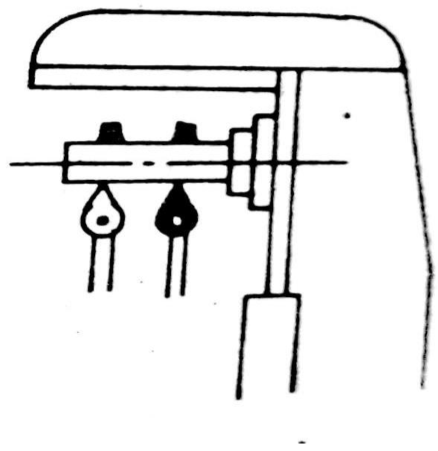
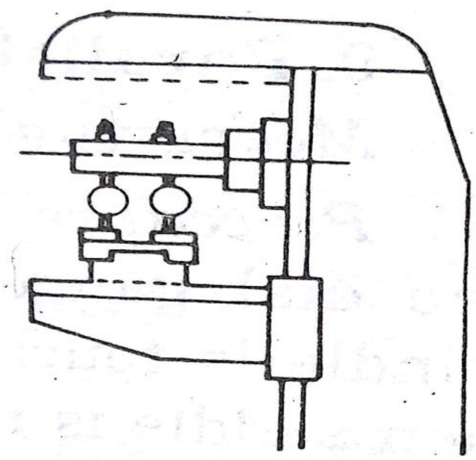


Figure-1 Figure-2



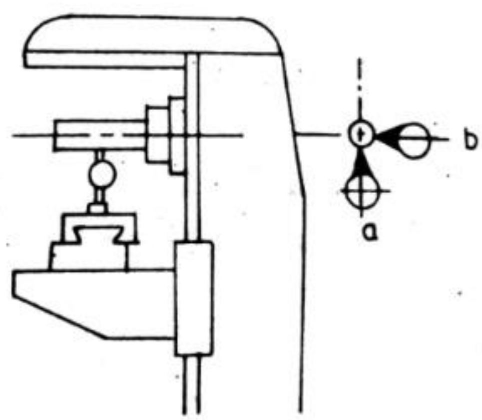


Figure-3 Figure-4

Precautions:

Before conducting the alignment test, it is essential to check the flatness by using the spirit level.

Result:

Alignment test is performed on milling machine and observed that the errors are within the permissible values.

EXPERIMENT NO: **DATE:**

MEASUREMENT OF GEAR TOOTH THICKNESS BY USING GEAR TOOTH VERNIER

Aim:

To measure the thickness of gear teeth at the pitch line or chordal thickness ofteeth and the distance from the top of a tooth the chord i.e. Addendum using geartooth caliper.

Apparatus:

- Gear Tooth Vernier Caliper,
- Gear Specimen,
- Vernier Caliper.

Procedure:

1. The given gear caliper is held over the gear and the slide is moved down so that it touches the top of the gear tooth.
2. The jaws are made to have contact with the tooth on either side by adjusting the knob.
3. The reading on vertical scale i.e. addendum is noted down.
4. The reading on horizontal scale i.e. tooth thickness is noted down.
5. The above procedure is repeated for three times and readings are noted.

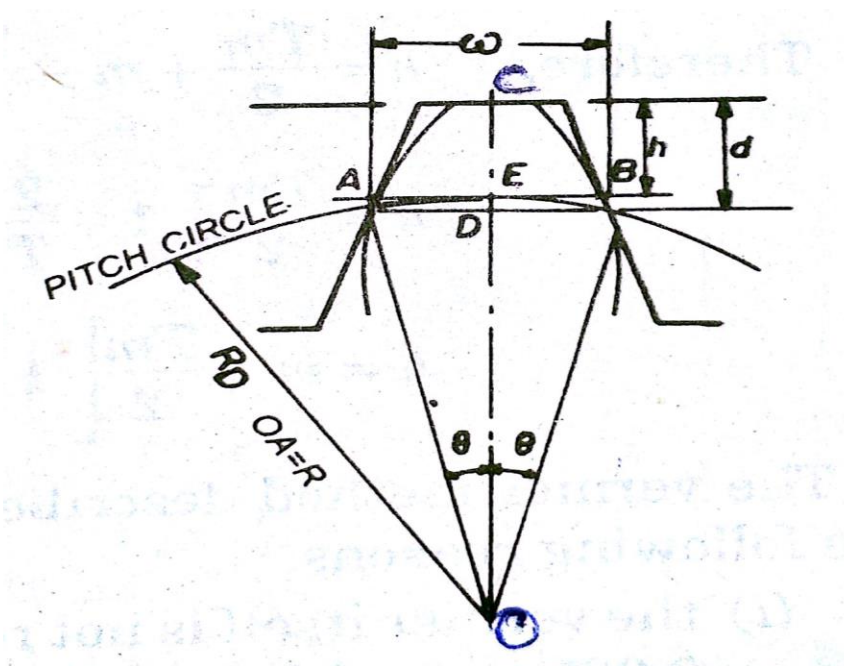


FIGURE: CHORDAL THICKNESS METHOD

Calculations:

Theoritical:

S.No	Parameter	Gear A	Gear B
1	Number of Teeth (T)		
2	Pitch Circle Diameter (D)		
3	Module (M)=D/T		
4	Chordal Thickness, w=N.M Sin (90/T)		
5	Chordal Addendum, h=m+Tm/2[1-Cos(90/T)]		

Actual:

For Chordal thickness

Sl. No.		MSR	VSR	VSR*LC	TR=MSR+(VSR*LC) (mm)
A	1.				
	2.				
	3.				
	4.				
					AVG=
B	1.				
	2.				
	3.				
	4.				
					AVG=

For Addendum

Sl. No.		MSR	VSR	VSR*LC	TR=MSR+(VSR*LC) (mm)
A	1.				
	2.				
	3.				

	4.				
					AVG=
	1.				
	2.				
B	3.				
	4.				
					AVG=

Precautions:

1. Clean the measuring faces of paper or cloth.
2. Set the zero reading of the instrument to before measuring.

Result:

Thus the addendum and tooth thickness of gear is measured using gear tooth Vernier caliper.

The Theoretical values are
Chordal Thickness, w =
Chordal Addendum, h =

The Actual values are
Chordal Thickness, w =
Chordal Addendum, h =

EXPERIMENT NO: DATE:

SURFACE ROUGHNESS MEASUREMENT OF MACHINED COMPONENT

AIM:

To measure the surface roughness of the given specimens using surface roughness tester.

MEASURING INSTRUMENTS AND MATERIAL REQUIRED:

- Surface roughness tester
- Precision roughness specimen, Test specimens, Calibration stage
- Slip gauge

THEORY:

Surface texture is deemed to include all those irregularities which, recurring many times across the surface, tend to form on it a pattern or texture. The irregularities in the surface texture which result from the inherent action of the production process is called roughness or primary texture. That component of surface texture upon which roughness is super imposed is called waviness or secondary texture. This may result from such factors as machine or work deflections, vibrations, chatter, heat treatment or warping strains. The direction of the predominant surface pattern, ordinarily determined by the production method used is called lay. The parameters of the surface are conveniently defined with respect to a straight reference line. The most widely used parameter is the arithmetic average departure of the filtered profile from the mean line. This is known as the CLA (Centre - Line - Average) or R_a (roughness average)

Arithmetic mean deviation of the Profile, R_a:

R_a is the arithmetic mean of the absolute values of the profile deviations from the mean line.

Root-mean-square deviation of the Profile, R_q:

Rq is the square root of the arithmetic mean of the squares of profile deviations from the mean line.

PROCEDURE:

Surface roughness measurement with the surf test includes

i) Mounting/dismounting the drive unit/detector, and cable connection, etc. according to the feature of the work piece to be measured,

ii) Selection of power supply i.e., either the AC adapter or built-in battery,
iii) Modifying the measurement conditions as necessary,
iv) Calibrating surf test to adjust the detector gain for correct measurements,

v) Measuring the roughness specimen and display the result.

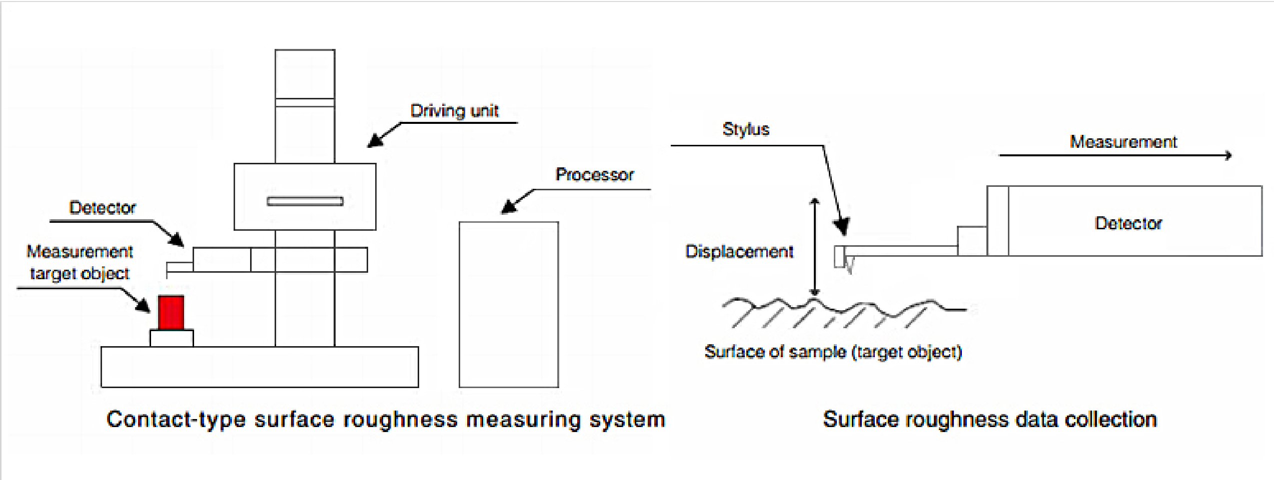
Actual measurement of roughness specimen:

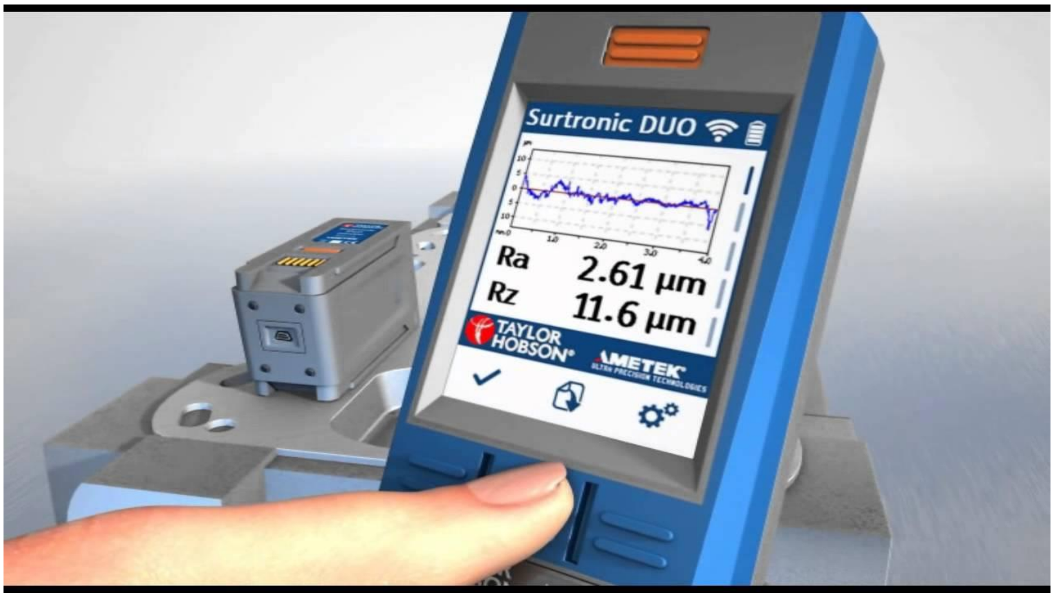
Surf Test is placed on the work piece, if the work piece surface is large enough. For measurement to be successful, it should be performed on a firm base that is insulated as well as possible from all sources of vibration. If measurement is performed being subject to significant vibrations, results may be unreliable.

i) Work piece is positioned so that the measured surface is level.

ii) Surf Test is placed on the work piece, In this operation surface roughness tester is supported by two reference surfaces at the bottom of driving unit. It must be confirmed that the probe is in proper contact with the measured surface and the detector is parallel to the measured surface.

Diagram:





Observation:

Surface Roughness of the specimen:

S.no	specimen	Position 1	Position 2	Position 3	Average surface Roughness (Ra)
1	Work Piece 1				
2	Work Piece 2				
3	Work Piece 3				

Result:

Surface roughness test is performed on given work pieces and observed the surface roughness value.

EXPERIMENT NO: DATE:

MEASUREMENT OF THREAD PARAMETERS BY USING TOOL MAKER'S MICROSCOPE

Aim:

To measure major diameter, minor diameter, pitch and thread angle of the screw thread.

Apparatus:

Tool maker's microscope, specimen.

Procedure:

The steps to be adopted for the experimental procedure are as follows:

1. Clamp the given screw thread on the table keeping the axis approximately horizontal.
2. Move the microscope in the X and Y directions to the vicinity of the screw thread profile.
3. Adjust the optical head for focusing the screw thread profile at the crosswires.

Measurement of major diameter:

The major diameter can be measured in the following way:

1. Coincide the horizontal cross-wire to the crest of the screw thread profile. Note down the initial reading.
2. Move the optical head along the Y-axis and coincide the horizontal cross-wire with the outermost point on the other side of the profile. Note down the final reading.
3. The difference between initial reading and final reading gives the major diameter.

Measurement of minor diameter:

The major diameter can be measured in the following way:

1. Coincide the horizontal cross-wire to the root of the screw thread profile. Note down the initial reading.
2. Move the optical head along the Y-axis and coincide the horizontal cross-wire with the root of the screw thread on the other side. Note down the final reading.
3. The difference between final reading and initial reading gives the minor diameter.

Measurement of pitch:

The pitch can be measured in the following way:

1. Coincide the vertical cross-wire approximately with the line of symmetry passing through the screw thread. Note down the initial reading.
2. Move the optical head along the X-axis and coincide the cross-wire with the adjacent screw thread. Note down the final reading.
3. The difference between initial reading and final reading gives the pitch of the screw thread.

Measurement of thread angle:

The thread angle can be measured in the following way:

1. For measuring the angle of the thread, the screen is rotated until a line on the screen coincides with one flank of the thread profile.
2. The angle of screen rotation is noted, and then the screen is further rotated till the same line coincides with the other flank of thread.
3. The difference between in two angular readings gives the angle of the thread

Calculations:

Parameter	**Trial No.**	**Initial Reading (IR)**			**Final Reading (FR)**			**Difference (IR-FR)**	**Average (mm)**
		MSR	**TSR*LC**	**TR**	**MSR**	**TSR*LC**	**TR**		
Major Diameter	**1**								
	2								
	3								
	4								
	5								

	1								
	2								
Minor Diameter	**3**								
	4								
	5								
	1								
	2								
Pitch	**3**								
	4								
	5								
	1								
	2								
Thread Angle	**3**								
	4								
	5								

Observations:
1 Least Count of vertical slide micrometer = 1 MSD/ No. of divisions on thimble
= 0.0005 mm or 5 microns.
2 Least Count of horizontal slide micrometer = 1 MSD/ No. of divisions on thimble
= 0.0005 mm or 5 microns.

Precautions:

1. Clamp the optical head at any desired position using clamping screw carefully.
2. Proper adjustment in placing the specimen on the worktable is required.

Result:

The majordiameter, minor diameter, pitch and thread angle of the screw thread is measured using Tool Maker's Microscope.

Majordiameter of a screw thread =
Minor diameter of a screw thread =
Pitch of a screw thread =
Thread angle of a screw thread =