Final: 07.01.2022

**Course Code:** 1950321 **Roll No:** **MLRS- R19**

# MARRI LAXMAN REDDY
## INSTITUTE OF TECHNOLOGY AND MANAGEMENT

**(AN AUTONOMOUS INSTITUTION)**

(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)

Accredited by NBA and NAAC with 'A' Grade & Recognized Under Section2(f) & 12(B)of the UGC act,1956

III B.Tech I Sem Regular End Examination, January 2022

**Metrology and Machine Tools**

**(MECH)**

**Time: 3 Hours.** **Max. Marks: 70**

Note: 1. Question paper consists: Part-A and Part-B.
2. In Part – A, answer all questions which carries 20 marks.
3. In Part – B, answer any one question from each unit.
Each question carries 10 marks and may have a, b as sub questions.

**PART- A**

**(10*2 Marks = 20 Marks)**

| | | | | | |
|---|---|---|---|---|---|
| 1. | a) | Define machine tool. | 2M | CO1 | BL1 |
| | b) | Differentiate between single and multi point cutting tools. | 2M | CO1 | BL2 |
| | c) | Define counter boring. | 2M | CO2 | BL1 |
| | d) | Why do we require quick return mechanism? | 2M | CO2 | BL1 |
| | e) | Define rake angle. | 2M | CO3 | BL2 |
| | f) | How a grinding wheel is specified? | 2M | CO3 | BL1 |
| | g) | What do you mean by interchangeability? | 2M | CO4 | BL1 |
| | h) | Differentiate between unilateral and bilateral tolerances. | 2M | CO4 | BL2 |
| | i) | What is Rz value in surface roughness? | 2M | CO5 | BL1 |
| | j) | Write formula for ten point method in roughness calculation. | 2M | CO5 | BL1 |

**PART- B**

**(10*5 Marks = 50 Marks)**

| | | | | | |
|---|---|---|---|---|---|
| 2 | a) | With a neat sketch, explain the geometry of a single point cutting tool. | 5M | CO1 | BL4 |
| | b) | Explain taper turning by any method with the help of a neat sketch. | 5M | CO1 | BL4 |
| | | **OR** | | | |
| 3 | | Describe the basic working principle and important parts of Lathe machine with a neat sketch. | 10M | CO1 | BL2 |
| 4 | a) | Explain briefly about boring operations. | 5M | CO2 | BL4 |
| | b) | Distinguish between shaper and planar. | 5M | CO2 | BL2 |
| | | **OR** | | | |
| 5 | | Draw a neat sketch of a drilling machine and explain its construction. | 10M | CO2 | BL4 |

| | | | | | |
|---|---|---|---|---|---|
| 6 | a) | Differentiate between up milling and down milling. | 5M | CO3 | BL2 |
| | b) | Explain lapping and honing with suitable examples. | 5M | CO3 | BL4 |
| | | **OR** | | | |
| 7 | | Explain in detail about grinding process. | 10M | CO3 | BL4 |
| 8 | a) | Define a fit. Explain the types of the fits. | 5M | CO4 | BL4 |
| | b) | Explain the hole basis system and shaft basis system. | 5M | CO4 | BL4 |
| | | **OR** | | | |
| 9 | | Explain optical instrument for angular measurements with an example. | 10M | CO4 | BL |
| 10 | a) | Explain the terminology of screw thread. | 5M | CO5 | BL |
| | b) | Explain two wire methods with a neat sketch. | 5M | CO5 | BL |
| | | **OR** | | | |
| 11 | | State the advantages and applications of Coordinate measuring machine. | 10M | CO5 | BL |

**---oo0oo---**

## EXAMINATION BRANCH

| | |
|---|---|
| **Academic Year** | 2021-2022 |
| **Year & Semester** | IIIrd year 1st sem |
| **Regulation** | R19 |
| **Branch** | Mech |
| **Course Code** | 1950321 |
| **Course Name** | MMT |
| **Course Faculty's** | K. Chaithanya |
| **Course Moderator** | K. Chaithanya |
| **Date of Exam** | 7/1/2022 |
| **Reporting Time & Sign** | 9.15 |

## KEY PAPER

| QNO | ANSWER | MARKS |
|---|---|---|
| 1. | **a) Define machine tool**<br>A machine tool is a machine for handling or machining metal or other rigid materials, usually by cutting, boring, grinding, shearing, or other forms of deformations.<br>**b) Differentiate between single and multi point cutting tools.**<br>Single point cutting tool has one cutting edge and multi has more than one cutting edge.<br>**c) Define counter boring.**<br>Counter boring is the operation of enlarging the end of the hole cylindrically. This is necessary in some cases to accommodate the heads of bolts, studs and pins.<br>**d) Why do we require quick return mechanism?**<br>For reducing the time in return stroke of cutting. That for reducing the ideal time of cutting.<br>**e) Define rake angle.**<br>It is the angle formed between face of the tool and plane parallel to its base Rake angle is provided for ease of chip flow and overall machining. | |

Rake angle may be positive, or negative or even zero.

Positive rake – helps reduce cutting force and thus cutting power requirement.

Negative rake – to increase edge-strength and life of the tool (eg: carbide tools).

Zero rake – to simplify design and manufacture of the form tools

**f) How a grinding wheel is specified?**

- Standard wheel markings
- Diameter of the wheel
- Bore diameter of the wheel
- Thickness of the wheel
- Type of the wheel

**g) What do you mean by interchangeability?**

The term interchangeability is normally employed for the mass production of identical items within the prescribed limits of size.

**h) Differentiate between unilateral and bilateral system.**

As evidenced, a bilateral tolerance is where the tolerance zone equally distributes on either side of the true profile line. And a unilateral tolerance is where the zone positions on one side of the line or the other.

**a) What is Rz value in surface roughness?**

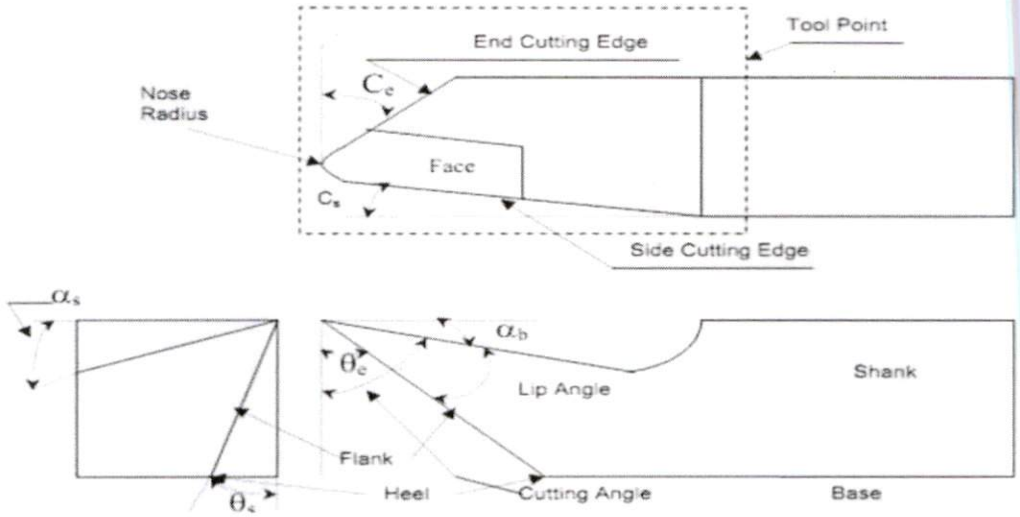
It is the difference between peak and valley in the surface.

**j) Write formula for ten point method in roughness calculation.**

If R = Ten point height of irregularities then,

$$R = \frac{1}{5}[(R_1 + R_2 + R_3 + R_4 + R_5) - (R_6 + R_7 + R_8 + R_9 + R_{10})]$$

| QNO | ANSWER | MARKS |
|---|---|---|
| 2. | **a) With a neat sketch, explain the geometry of a single point cutting tool.** | FIG :2M |




**Rake angle:** It is the angle formed between face of the tool and plane parallel to its base. If this inclination is towards shank, it is known as back rake or top rake. When it is measured towards side of the tool, it is called side rake. These rake angles guide the chips away from the cutting edge, thereby reducing the chip pressure on the face and increasing the keenness of the tool, so that less power is required for cutting. An increased rake angle will reduce the strength of cutting edge. Therefore, tools used for cutting hard materials are given small rake angles, whereas those used for soft metals contain large rake angles.

**1. Negative rake angle:** The above rake angles are called positive rake angles. When no rake is provided on the tool, it is said to have zero rake angle. When the face of the tool is so ground that it slopes upwards from the point, it is said to contain a negative rake. It reduces keenness of the tool and increases the strength of cutting edge. Such rake is usually provided on carbide tipped tools when they are used for machining extra- hard surfaces, hardened steel parts and for taking intermittent cuts. The values of negative rake on these tools normally vary from 5 to$10^{\circ}$.

**2. Lip angle:** The angle between the face and flank of the tool is known as Lip angle. It is also called angle of keenness of the tool. Strength of the cutting edge or point of the tool is directly affected by this angle. Larger the lip angle, stronger will be cutting edge and vice- versa. This angle varies inversely as the rake angle. It is only for this reason that when harder metals are to be machined a stronger tool is required, the rake angle is reduced and consequently the lip angle is increased. This calls for reduced cutting speeds, which is dis- advantage. The lip angle is therefore kept as low as possible without making the cutting edge so weak that it becomes unsuitable for cutting.

**3. Clearance angle:** It is the angle formed by the front or side surface of the tool which are adjacent and below the cutting edge when the tool is held in a horizontal position. It is the angle between one of these surfaces and a plane normal to the base of the tool. When the front surface is considered it is called front clearance and when the surface below cutting edge is considered, the angle formed is known as side clearance angle. The purpose of providing front clearance is to allow the tool to cut freely without rubbing against the surface of the job. The side clearance is to direct the cutting thrust to the metal area adjacent to the cutting edge.

**4. Relief angle:** It is the angle formed between flank of the tool and a perpendicular drawn from the cutting point to the base of the tool.

**5. Cutting angle:** The total cutting angle of the tool is the angle formed between the tool face and a line drawn through the point, which is a tangent to the machined surface of the work at that point. Its correct value depends upon the position of the tool in which it is held in relation to the axis of the job.

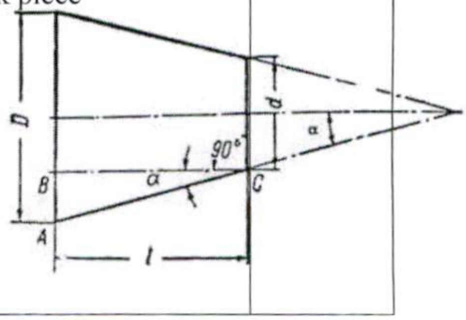
**6. Nose radius:** If the cutting tip of a single point tool carries a sharp cutting point, the cutting tip is weak. It is therefore highly stressed during the operation, may fail or lose its cutting ability soon and produces marks on the machined surface. In order to prevent these harmful effects the nose is provided with a radius, called Nose radius. It enables greater strength to cutting tip, a prolonged tool life and superior surface finish on the work piece. As the value of this radius increases, higher cutting speeds can be used.

If it is too large, it may lead to chatter. So a balance has to be maintained. Its value normally varies from 0.4mm to 1.6mm depending upon several factors like depth of cut, amount of feed, type of cutting and type of tool.

**b) Explain taper turning by any method with the help of a neat sketch.** **FIG :2M**

**( NOTE: Consider only one method )**

A taper may be defined as a uniform change in the diameter of a work piece measured along its length. Taper may be expressed in two ways:




Ratio of difference in diameter to the length.
In degrees of half the included angle.
Fig. 2.31 shows the details of a taper.
D – Larger diameter of the taper.
d – Small diameter of the taper.
l – Length of tapered part.

α - Half angle of taper.

Fig. 1.19 Details of a taper

Generally, taper is specified by the term conicity.

Conicity is defined as the ratio of the difference in diameters of the taper to its length.

Conicity, **K**=2.1

Taper turning is the operation of producing conical surface on the cylindrical work piece on lathe.

**Taper turning by a form tool**

Fig. 1.20 illustrates the method of turning taper by a form tool. A broad nose tool having straight cutting edge is set on to the work at half taper angle, and is fed straight into the work to generate a tapered surface. In this method the tool angle should be properly checked before use. This method is limited to turn short length of taper only. This is due to the reason that the metal is removed by the entire cutting edge will require excessive cutting pressure, which may distort the work due to vibration and spoil the work surface.

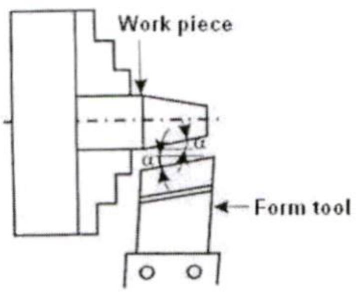



Fig. 1.20 Taper turning by a form tool

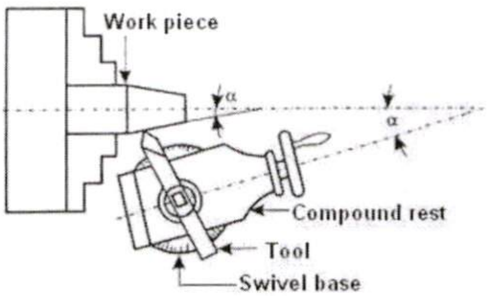



Fig. 1.21 Taper turning by swiveling the compound rest

**Taper turning by swiveling the compound rest**

Fig. 1.21 illustrates the method of turning taper by swiveling the compound rest. This method is used to produce short and steep taper. In this method, work is held in a chuck and is rotated about the lathe axis. The compound rest is swiveled to the required angle and clamped in position.

The angle is determined by using the formula, **tan** α = 2.2

Then the tool is fed by the compound rest hand wheel. This method is used for producing both internal and external taper. This method is limited to turn a short taper owing to the limited movement of the compound rest. The compound rest may be swiveled at 45 on either side of the lathe axis enabling it to turn a steep taper. The movement of the tool in this method being purely controlled by hand, this gives a low production capacity and poorer surface finish.

**Taper turning by offsetting the tailstock**

Fig. 1.22 illustrates the method of turning taper by offsetting the tailstock. The principle of turning taper by this method is to shift the axis of rotation of the work piece, at an angle to the lathe axis, which is equal to half angle of the taper, and feeding the tool parallel to the lathe axis.

This is done when the body of the tailstock is made to slide on its base towards or away from the operator by a set over screw. The amount of set over being limited, this method is suitable for turning small taper on long jobs. The main disadvantage of this method is that live and dead centers are not equally stressed and the wear is not uniform. Moreover, the lathe carrier being set at an angle, the angular velocity of the work is not constant.

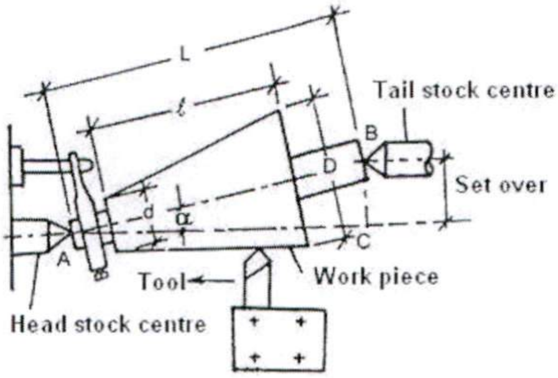



Fig. 1.22 Taper turning by offsetting the tailstock

The amount of set over required to machine a particular taper may be calculated as:
From the right-angle triangle ABC in Fig.1.22;
BC =AB sin α, where BC = set over
**Set over = L sin α** 2.3 in mm.
If the half angle of taper (α), is very small, for all practical purposes, sin α = tan α
**Set over = L tan α = Lx** 2.4 in mm.
If the taper is turned on the entire length of the work piece, then l= L, and the equation (2.4) becomes:
**Set over = Lx** = 2.5 in mm
Beingtermedastheconicityoramountoftaper,theformula(2.4)maybewritteninthefollowing form:
**Set over** = 2.6 in mm

**Taper turning by using taper turning attachment**

Fig. 1.23 schematically shows a taper turning attachment. It consists of a bracket or frame which is attached to the rear end of the lathe bed and supports a guide bar pivoted at the center. The guide bar having graduations in degrees may be swiveled on either side of the zero graduation and is set at the desired angle with the lathe axis. When this attachment is used the cross slide is delinked from the saddle by removing the binder screw. The rear end of the cross slide is then tightened with the guide block by means of a bolt. When the longitudinal feed is engaged, the tool mounted on the cross slide will follow the angular path, as the guide block will slide on the guide bar set at an angle to the lathe axis.

**Taper turning by using taper turning attachment**

Fig. 1.23 schematically shows a taper turning attachment. It consists of a bracket or frame which is attached to the rear end of the lathe bed and supports a guide bar pivoted at the center. The guide bar having graduations in degrees may be swiveled on either side of the zero graduation and is set at the desired angle with the lathe axis. When this attachment is used the cross slide is delinked from the saddle by removing the binder screw. The rear end of the cross slide is then tightened with the guide block by means of a bolt. When the longitudinal feed is engaged, the tool mounted on the cross slide will follow the angular path, as the guide block will slide on the guide bar set at an angle to the lathe axis.

The required depth of cut is given by the compound slide which is placed at right angles to the lathe axis. The guide bar must be set at half taper angle and the taper on the work must be converted in degrees. The maximum angle through which the guide bar may be swiveled is 10 to 12 on either side of the center line. The angle of swiveling the guide bar can be determined from the equation 2.2.

**The advantages of using a taper turning attachment are:**

The alignment of live and dead centers being not disturbed; both straight and taper turning may be performed on a work piece in one setting without much loss of time.

Once the taper is set, any length of work piece may be turned taper within its limit.

Very steep taper on a long work piece may be turned, which cannot be done by any other method. Accurate taper on a large number of work pieces may be turned. Internal tapers can be turned with ease.

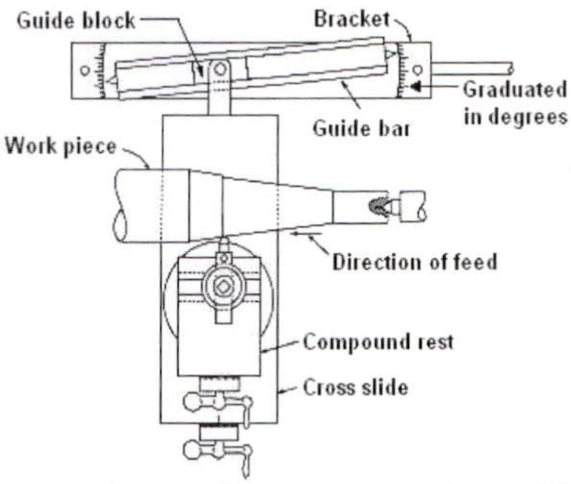



Fig 1.23 Taper turning by using taper turning attachment

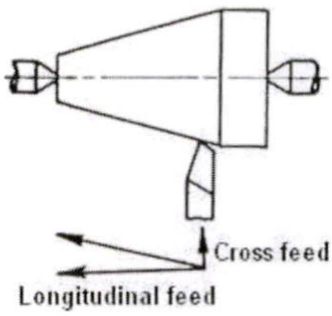



Fig 1.24 Taper turning by combining longitudinal feed and cross feed

**Taper turning by combining longitudinal feed and cross feed**

Fig. 1.24 illustrates the method of turning taper by combining longitudinal feed and cross feed. This is a more specialized method of turning taper. In certain lathes both longitudinal and cross feeds may be engaged simultaneously causing the tool to follow a diagonal path which is the resultant of the magnitude of the two feeds. The direction of the resultant may be changed by varying the rate of feeds by changing gears provided inside the apron.

| QNO | ANSWER | MARKS |
|---|---|---|
| 3. | **Describe the basic working principle and importance parts of the lathe machine with a neat sketch.** | FIG :3M |

**CONSTRUCTIONAL FEATURES**

**Major parts of a center lathe:**

Amongst the various types of lathes, center lathes are the most versatile and commonly used.

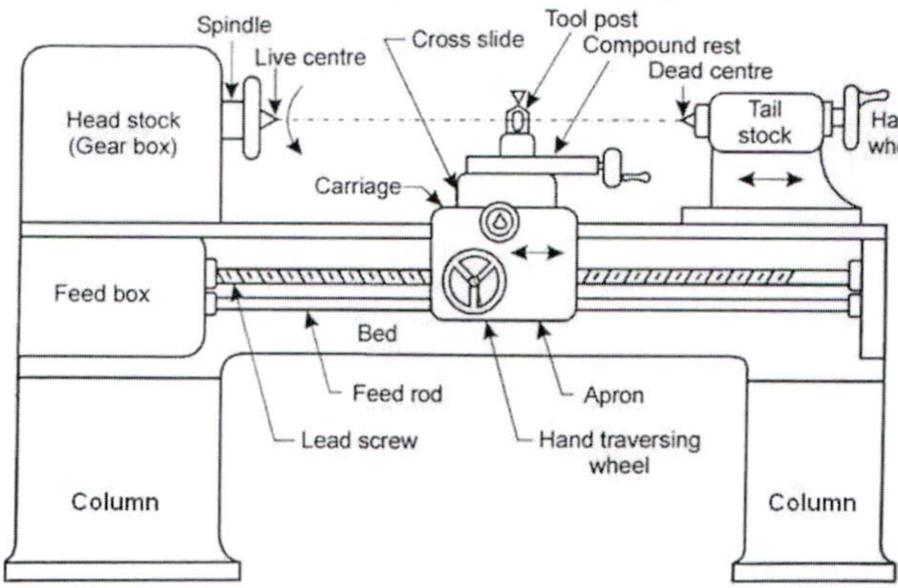



Fig. 1.5 shows the basic configuration of a center lathe.

**The major parts are:**

**Headstock:** It holds the spindle and through that power and rotation are transmitted to the job at different speeds. Various work holding attachments such as three jaw chucks, collets, and centres can be held in the spindle. The spindle is driven by an electric motor through a system of belt drives and gear trains. Spindle rotational speed is controlled by varying the geometry of the drive train.

**Tailstock:** The tailstock can be used to support the end of the work piece with a center, to support longer blanks or to hold tools for drilling, reaming, threading, or cutting tapers. It can be adjusted in position along the ways to accommodate different length work pieces. The tailstock barrel can be fed along the axis of rotation with the tailstock hand wheel.

**Bed:** Headstock is fixed and tailstock is clamped on it. Tailstock has a provision to slide and facilitate operations at different locations. The bed is fixed on columns and the carriage travels on it.

**Carriage:** It is supported on the lathe bed-ways and can move in a direction parallel to the lathe axis. The carriage is used for giving various movements to the tool by hand and by power. It carries saddle, cross-slide, compound rest, tool post and apron.

**Saddle** It carries the cross slide, compound rest and tool post. It is an H-shaped casting fitted over the bed. It moves alone to guide ways.

**Cross-slide:** It carries the compound rest and tool post. It is mounted on the top of the saddle. It can be moved by hand or may be given power feed through apron mechanism.

**Compound rest:** It is mounted on the cross slide. It carries a circular base called swivel plate which is graduated in degrees. It is used during taper turning to set the tool for angular cuts. The upper part known as compound slide can be moved by means of a hand wheel.

**Tool post:** It is fitted over the compound rest. The tool is clamped in it.

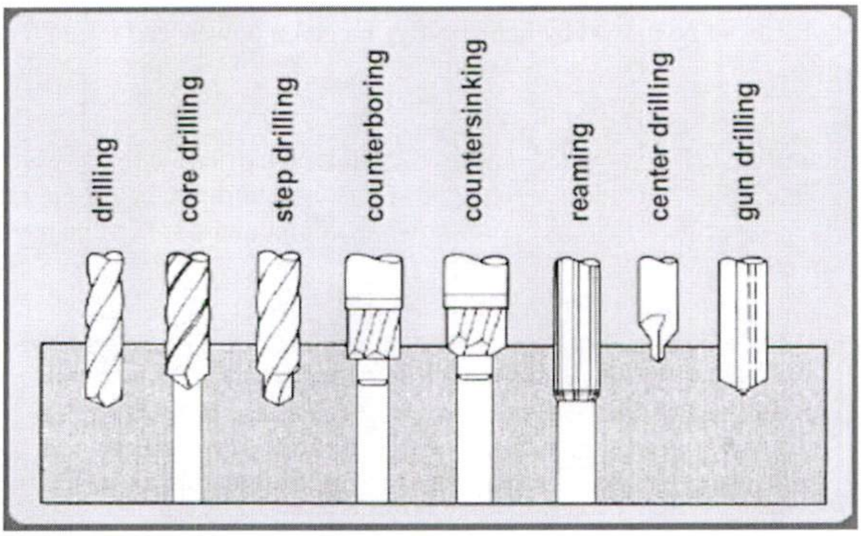
**Apron** Lower part of the carriage is termed as the apron. It is attached to the saddle and hangs in front of the bed. It contains gears, clutches and levers for moving the carriage by a hand wheel or power feed.

**Feed mechanism:** The movement of the tool relative to the work piece is termed as "feed". The lathe tool can be given three types of feed, namely, longitudinal, cross and angular. When the tool moves parallel to the axis of the lathe, the movement is called longitudinal feed. This is achieved by moving the carriage. When the tool moves perpendicular to the axis of the lathe, the movement is called cross feed. This is achieved by moving the cross slide. When the tool moves at an angle to the axis of the lathe, the movement is called angular feed. This is achieved by moving the compound slide, after swiveling it at an angle to the lathe axis.

**Feed rod:** The feed rod is a long shaft, used to move the carriage or cross-slide for turning, facing, boring and all other operations except thread cutting. Power is transmitted from the lathe spindle to the apron gears through the feed rod via a large number of gears.

**Lead screw:** The lead screw is long threaded shaft used as a master screw and brought into operation only when threads have to cut. In all other times the lead screw is disengaged from the gear box and remains stationary. The rotation of the lead screw is used to traverse the tool along the work to produce screw. The half nut makes the carriage to engage or disengage the lead screw.

| QNO | ANSWER | MARKS |
|---|---|---|
| 4. | **a) Explain briefly about boring operations**<br>I. Boring<br>II. Counter boring<br>III. Counter sinking | FIG :2M |




**1. Boring:** It is an operation used for enlarging a hole to bring it to the required size and have a better finish. It involves the use of an adjustable cutting tool having a single cutting edge. It can be used for correcting the hole location and out of roundness, if any, as the tool can be adjusted to remove more metal from one side of the hole than the other. It is a slower process than reaming. The accuracy to be expected is within ±0.0125mm.

**2. Counter Boring:** The operation is used for enlarging only a limited portion of the hole is called counter-boring. It can be performed by means of a double tool boring bar or a counter boring tool. In order to maintain alignment and true concentricity of the counter bored hole with the previously drilled hole, the counter boring tool is provided with a pilot at its bottom.

**3. Counter Sinking:** It is the operation used for enlarging the end of a hole to give it a conical shape for a short distance. This is done for providing a seat for the counter sunk heads of screws, so that the top face of screw matches with the main surface of work. The standard counter sunk carry included angle of $60^0$, $82^0$ or $90^0$.

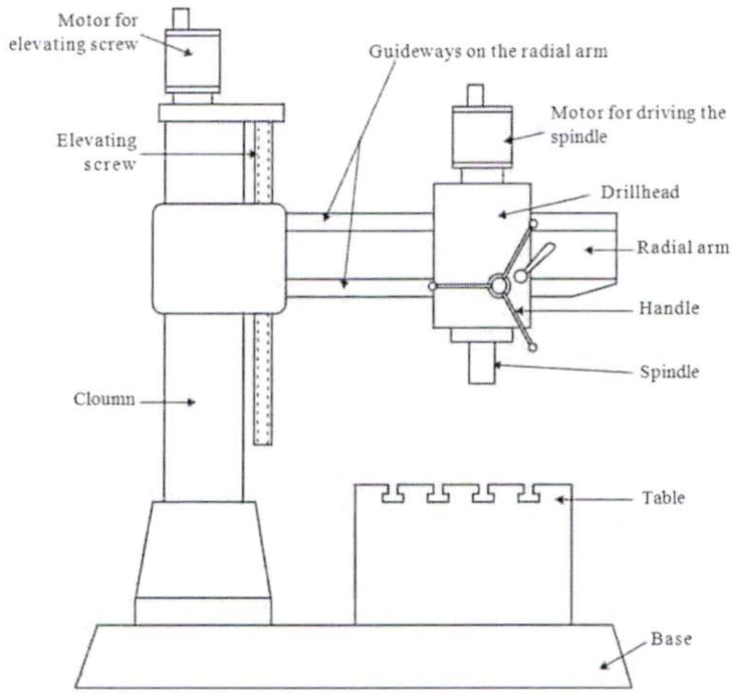
**b) Distinguish between shaper and planer.**

| S.No | PLANER | SHAPER |
|---|---|---|
| 1. | It is heavier, more rigid and costlier m/c. | Comparatively lighter and cheap m/c. |
| 2. | It requires more floor area. | Less floor area. |
| 3. | It is used for machining large flat surfaces horizontal. Vertical and inclined. | It is also used for the same purposes but for relatively smaller surfaces. |
| 4. | Cutting takes place by reciprocating the work under the tool. | Cutting takes places by moving the cutting tool over the job. |
| 5. | Indexed feed is given to tool during the idle stroke of the work table. | Indexed feed is given to the work during the idle stroke of the ram. |
| 6. | Heavier cuts and coarse feed can be used. | Very heavy cuts and coarse feeds can't be used. |
| 7. | Four tools can be used simultaneously facilitating a faster rate of production. | Only one tool can be used on a shaper. |
| 8. | Because of its larger stroke length and table size, number of jobs can be held in series and machined in single setting. | This is not possible on a shaper. |
| 9. | The tools used are longer, heavier and stronger. | Tools are smaller and lighter. |
| 10. | The work is held on the machine table by means of fixtures and clamping devices. | The work is clamped directly on the table or held in a vice or chuck. |

| QNO | ANSWER | MARKS |
|---|---|---|
| 5. | **Draw a neat sketch of a drilling machine and explain its construction.** | **FIG :3M** |

**( NOTE : ANY drilling machine he can explain )**

- The radial drilling machine is intended for drilling on medium to large and heavy work pieces.
- It has a heavy round column mounted on a large base.
- The column supports a radial arm, which can be raised or lowered to enable the table to accommodate work pieces of different heights.
- The arm, which has the drill head on it, can be swung around to any position.
- The drill head can be made to slide on the radial arm.
- The machine is named so because of this reason.
- It consists of parts like base, column, radial arm, drill head and driving mechanism




**Radial drilling machine**

**Base** – The base is a large rectangular casting and is mounted on the floor of the shop. Its top is accurately finished to support a column at one end and the table at the other end. 'T'-slots are provided on it for clamping work pieces.

**Column** – The column is a cylindrical casting, which is mounted vertically at one end of the base. It supports the radial arm and allows it to slide up and down on its face. The vertical adjustment of the radial arm is effected by rotating a screw passing through a nut attached to the arm. An electric motor is mounted on the top of the column for rotating the elevating screw.

**Radial arm** – The radial arm is mounted on the column parallel to the base and can be adjusted vertically. The vertical front surface is accurately machined to provide guide ways for the drill head. The drill head can be adjusted along these guide ways according to the location of the work. In some machines, a separate motor is provided for this movement. The arm may be swung around the column. It can also be moved up and down to suit work pieces of different heights

**Drill head** –

The drill head is mounted on the radial arm and houses all mechanism for driving the drill at different speeds and at different feed.

A motor is mounted on top of the drill head for this purpose. To adjust the position of drill spindle with respect to the work, the drill head may be made to slide on the guide ways of the arm.

The drill head can be clamped in position after the spindle is properly adjusted.

| QNO | ANSWER | MARKS |
|---|---|---|
| 6. | **a) Differentiate between Up Milling and Down Milling.**<br>**Conventional Milling (Up Milling)**<br>• Max chip thickness is at the end of the cut<br>• Advantage: tooth engagement is not a function of work piece surface characteristics, and contamination or scale on the surface does not affect tool life.<br>• Cutting process is smooth<br>• Tendency for the tool to chatter<br>• The work piece has a tendency to be pulled upward, necessitating proper clamping<br>**Climb Milling (Down Milling)**<br>• Cutting starts at the surface of the work piece.<br>• Downward compression of cutting forces hold work piece in place<br>• Because of the resulting high impact forces when the teeth engage the work piece, this operation must have a rigid setup, and backlash must be eliminated in the table | **FIG :2M** |

feed mechanism

- Not suitable for machining work piece having surface scale

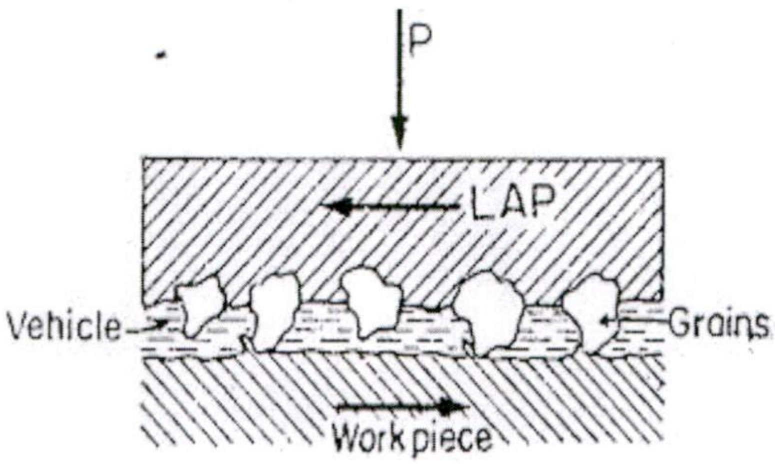
**b) Explain lapping and honing with suitable examples** — **FIG :2M**

**Lapping:**

Lapping is regarded as the oldest method of obtaining a fine finish. Lapping is basically an abrasive process in which loose abrasives function as cutting points finding momentary support from the laps. Figure 30.1 schematically represents the lapping process. Material removal in lapping usually ranges from .003 to .03 mm but many reach 0.08 to 0.1mm in certain cases

**Characteristics of lapping process:** Use of loose abrasive between lap and the work piece. Usually lap and work piece are not positively driven but are guided in contact with each other Fig. 30.1. Scheme of lapping process. Relative motion between the lap and the work should change continuously so that path of the abrasive grains of the lap is not repeated on the work piece.

Abrasive particle Cast iron is the mostly used lap material. However, soft steel, copper, brass, hardwood as well as hardened steel and glass are also used.

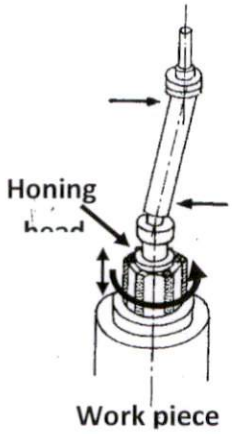



**Honing:**

Honing is a finishing process, in which a tool called hone carries out a combined rotary and reciprocating motion while the work piece does not perform any working motion. Most honing is done on internal cylindrical surface, such as automobile cylindrical walls. The honing stones are held against the work piece with controlled light pressure. The honing head is not guided externally but, instead, floats in the hole, being guided by the work surface (Fig.). It is desired that

1. honing stones should not leave the work surface
2. Stroke length must cover the entire work length.

In honing rotary and oscillatory motions are combined to produce a cross hatched lay pattern as illustrated in Fig.



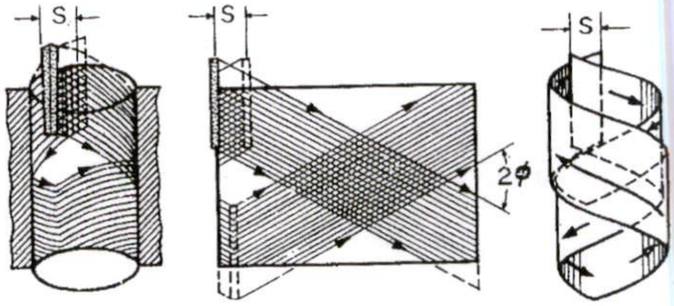




**Fig.** Honing tool

**Fig.** Lay pattern produced by combination of rotary and oscillatory motion

| QNO | ANSWER | MARKS |
|---|---|---|
| 7. | **Explain in detail about grinding process.** | **FIG :3M** |

**GRINDING MACHINE**

Grinding is a process of removing material by the abrasive action of a revolving wheel on the surface of a work piece, in order to bring it to the required shape and size. Grinding is similar to other machining operations since the material is removed in the form of very small chips, similar to those obtained in other machining operations. The wheel used for performing the grinding operation is known as "Grinding Wheel". It consists of sharp crystals, called abrasives, held together by a binding material or bond .It may be a single piece type or several segments joined together. In most of the cases, it is a finishing operation and a very small amount of material is removed from the surface during the operation

**ABRASIVES:** It is the material of the grinding wheel, which does cutting action. These are extremely hard materials, consisting of very small particles, called grains, which carry a number of sharp cutting edges and corners. They are two types.

1). Natural

2). Artificial

**Natural Abrasives:** They are obtained directly from mines. The common natural abrasives are sand stone, emery, corundum, Quartz and diamond.

All the natural abrasives, except diamond are now obsolete. Sand stone is used only for sharpening wood working tools. All other natural abrasives are almost replaced by artificial abrasives. Diamond, still retains its place even in modern grinding processes. It is largely used for dressing grinding wheels and for grinding hard materials.

**Artificial Abrasives:** They are manufactured under controlled conditions in closed electric furnaces to avoid impurities and to achieve necessary temperature for the chemical reaction to take place. The main artificial abrasives are: Sic Aluminum Oxide.

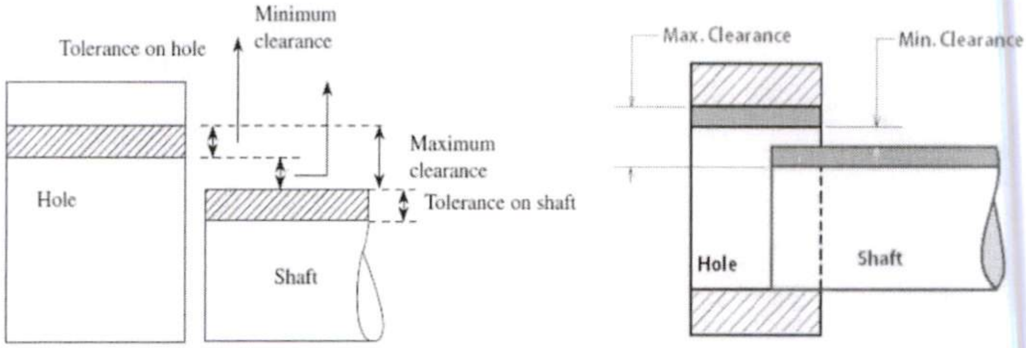
**Advantages and uses of artificial abrasives:**

- The manufactured or artificial abrasives superseded the natural abrasives for the following reasons:
- The controlled conditions in the electric furnace enable uniformity in the product.
- The quantity of production and supply can easily be varied according to the demands.
- They have largely abolished the dependence on natural means to meet the growing demand in the modern manufacturing processes.
- The selection of a particular abrasive is governed by many factors, like hardness, toughness and other properties of work material.

| QNO | ANSWER | MARKS |
|---|---|---|
| 8. | **a) Define a fit. Explain the types of the fits.**<br>Manufactured parts are required to mate with one another during assembly. The relationship between the two mating parts that are to be assembled, that is, the hole and the shaft, with respect to the difference in their dimensions before assembly is called a *fit.* An ideal fit is required for proper functioning of the mating parts. Three basic types of fits can be identified, depending on the actual limits of the hole or shaft:<br>1. Clearance fit<br>2. Interference fit<br>3. Transition fit | **FIG :2M** |

## FITS

1. **Clearance fit** Upper limit of shaft is less than the lower limit of the hole.

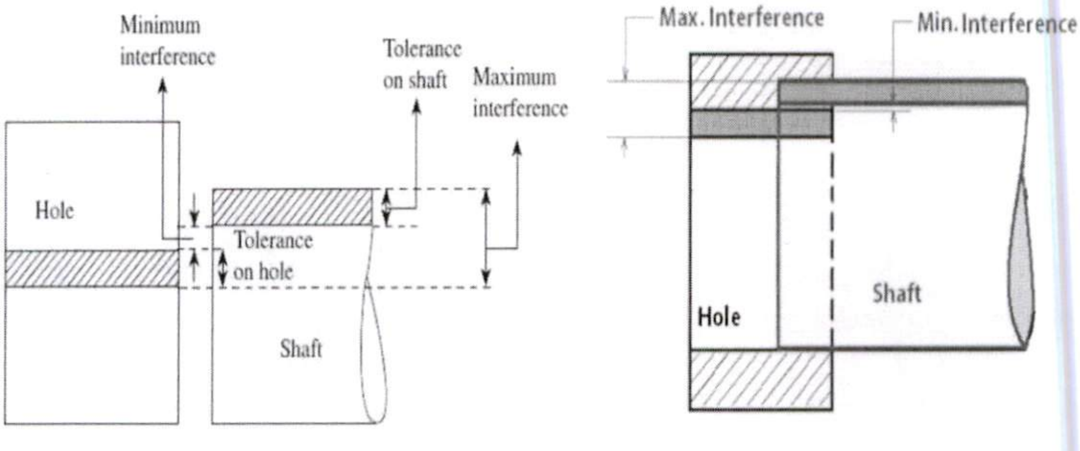



The largest permissible dia. of the shaft is smaller than the dia. of the smallest hole.

E.g.: Shaft rotating in a bush

## FITS

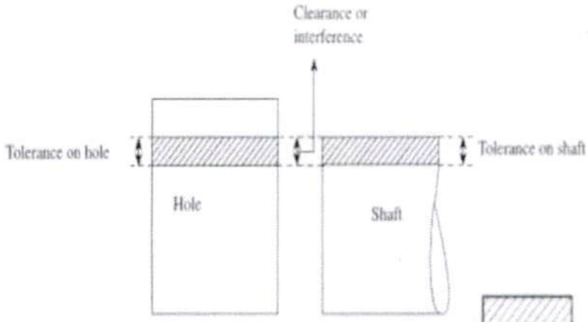
2. **Interference fit** Upper limit of the hole is less than the lower limit of shaft.

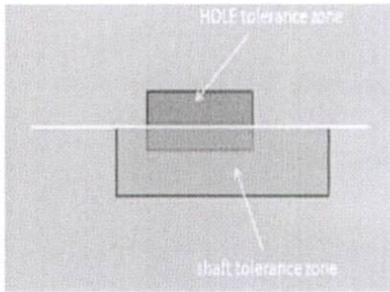


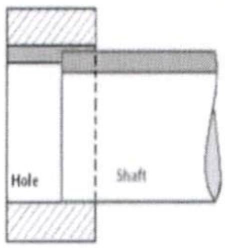

- No gap between the faces and intersecting of material will occur.
- Shaft need additional force to fit into the hole.

### 3. Transition fit

Dia. of the largest permissible hole is greater than the dia. of the smallest shaft.




- Neither loose nor tight like clearance fit and interference fit.
- Tolerance zones of the shaft and the hole will be overlapped between the interference and clearance fits.

**b) Explain the hole basis system and shaft basis system.** **FIG :2M**

**Hole Basis and Shaft Basis Systems**

- To obtain the desired class of fits, either the size of the hole or the size of the shaft must vary.

Two types of systems are used to represent three basic types of fits, clearance, interference, and transition fits.

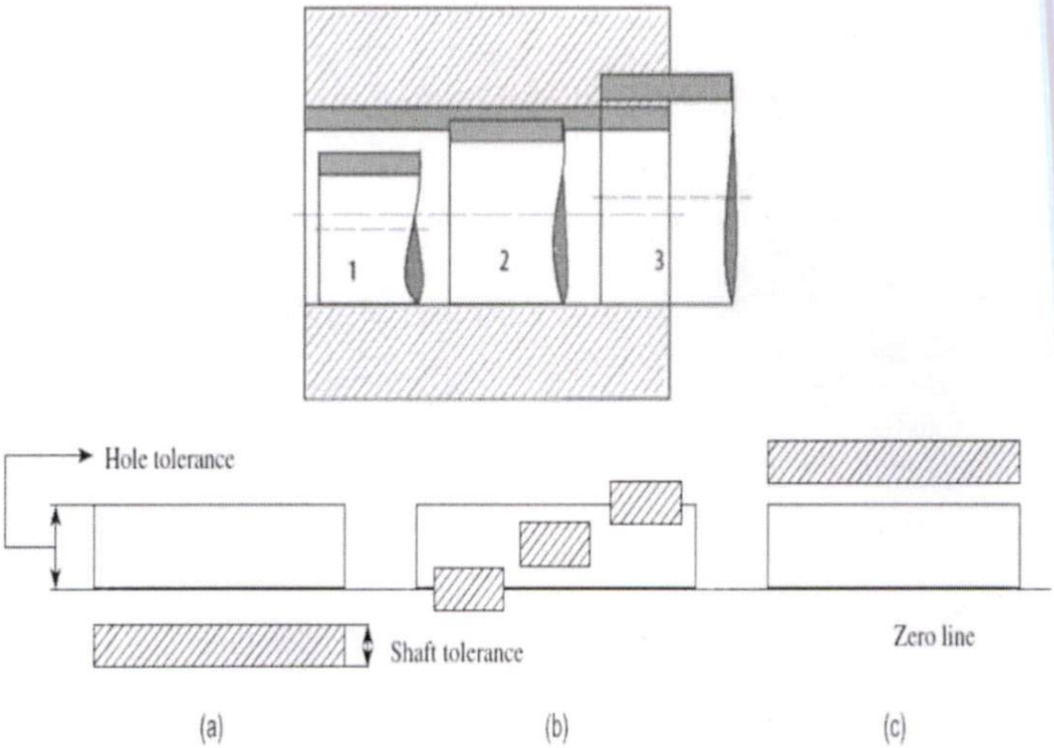
(a) Hole basis system

(b) Shaft basis system.

## Hole Basis systems

- The size of the hole is kept constant and the shaft size is varied to give various types of fits.
- Lower deviation of the hole is zero, i.e. the lower limit of the hole is same as the basic size.
- Two limits of the shaft and the higher dimension of the hole are varied to obtain the desired type of fit.

### Hole Basis systems

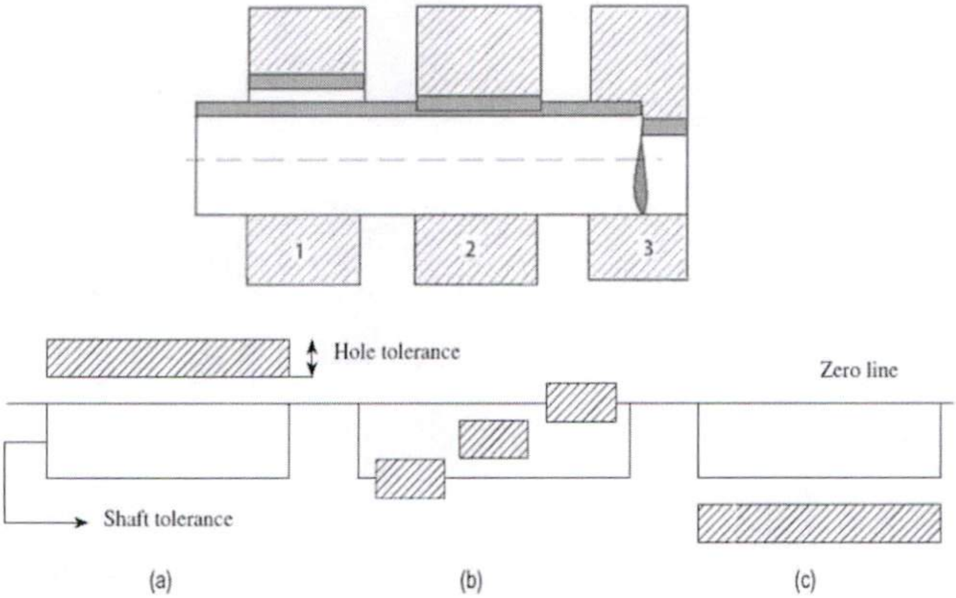



(a) Clearance fit (b) Transition fit (c) Interference fit

Shaft Basis systems

- The size of the shaft is kept constant and the hole size is varied to obtain various types of fits.
- Fundamental deviation or the upper deviation of the shaft is zero.
- System is not preferred in industries, as it requires more number of standard-size tools, like reamers, broaches, and gauges, increases manufacturing and inspection costs.

Shaft Basis systems




(a) Clearance fit (b) Transition fit (c) Interference fit

| QNO | ANSWER | MARKS |
|---|---|---|
| 9. | **Explain optical instrument for angular measurements with an example.** | **FIG :3M** |

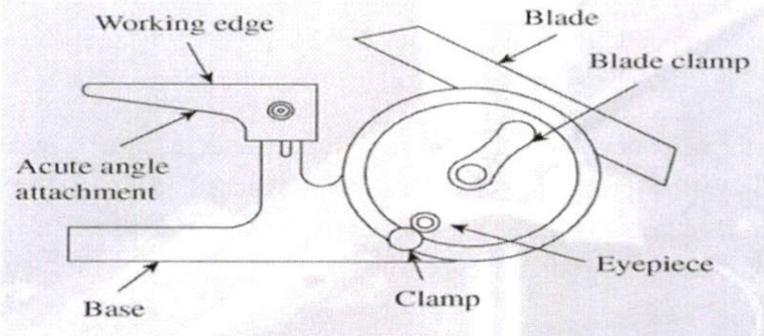
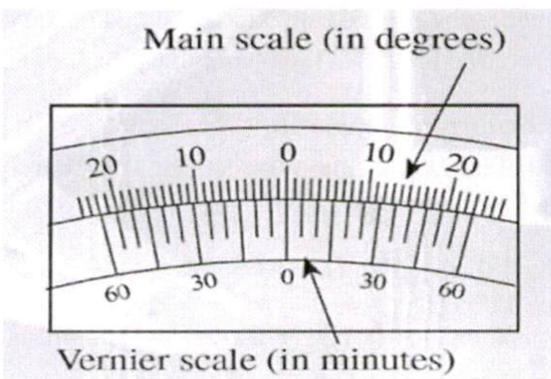



**Fig. 5.6** Optical bevel protractor

- The universal bevel protractor with 5 minutes accuracy is commonly found in all tool rooms and metrology laboratories.
- It has a base plate or stock whose surface has high degree of flatness and surface finish. The stock is placed on the work-piece whose angle is to be measured.
- An adjustable blade attached to a circular dial is made to coincide with the angular surface. It can be swiveled to the required angle and can be locked into position to facilitate accurate reading of the circular scale that is mounted on the dial
- The main scale on the dial is divided into four quadrants of 90 degrees each. Each division on this scale reads one degree. The degrees are numbered from 0 to 90 on either side of $0^{th}$ division.
- The vernier scale has 24 divisions, which correspond to 46 divisions on the main scale. However, the divisions on the vernier scale are numbered from 0 to 60 on either side of the $0^{th}$ division as shown in figure below



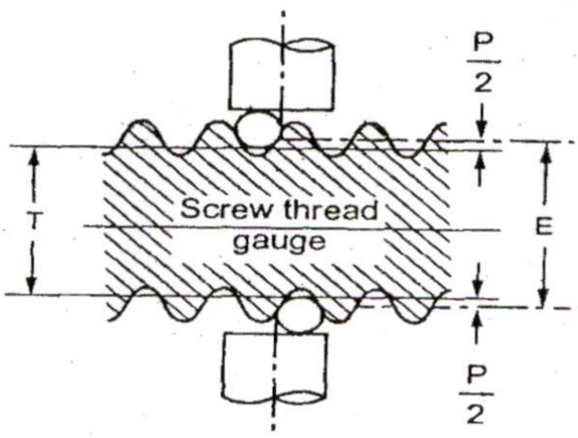
| | | |
|---|---|---|
| | • Optical protractor is a simple extension of the universal bevel protractor. A lens in the form of an eye-piece is provided to facilitate easy reading of the protractor scale.<br>• The blade is clamped to the dial by means of a blade clamp. This enables fitting blades of different lengths depending on the work part being measured.<br>• In a protractor without vernier, the dial scale reading can be directly read through the eye-piece. In vernier protractors, the eye-piece is attached on top of the vernier scale itself, which together move as a single unit over the stationary dial scale. The eye-piece provides a magnified view of the reading for the convenience of the user. | |

| QNO | ANSWER | MARKS |
|---|---|---|
| 10. | **a) Explain the terminology of screw thread**<br>• **Pitch:** The distance from a point on a screw thread to a corresponding point on the next thread measured parallel to the axis.<br>• **Lead** The distance a screw thread advances in one turn. For a single start threads, lead=pitch, For double start, lead=2xpitch, & so on.<br>• **Thread Form**: The cross section of thread cut by a plane containing the axis.<br>• **Major Diameter**: This is the diameter of an imaginary cylinder, co- axial with the screw, which just touches the crests of an external thread or roots of an internal thread. It is also called as 'Nominal diameter'<br>• **Minor diameter**: This is the diameter of an imaginary cylinder, co-axial with the screw which just touches the roots of an external thread or the crest of an internal thread. This is also referred to as 'root' or 'core diameter'.<br>• **Effective diameter or Pitch diameter**: It is the diameter of an imaginary cylinder coaxial with the axis of the thread and intersects the flanks of the thread such that width of the threads & width of spaces between threads are equal.<br>• **Flank:** It is the Thread surface that connects crest with root.<br>• **Depth of thread**: It is the distance between crest and root measured perpendicular to axis of screw. | |

- **Angle of thread**: Included angle between sides of thread measured in axial plane.
- **Helix angle**: Angle that the thread makes with plane perpendicular to thread axis.
- **Flank angle**: It is half the included angle of the thread.
- **Addendum**: It is the distance between the crest and the pitch line measured perpendicular to axis of the screw.
- **Duodenum:** It is the distance between the pitch line & the root measured perpendicular to axis of the screw.

**b) Explain two wire methods with a neat sketch.** **FIG :2M**

- The effective diameter cannot be measured directly but can be calculated from the measurements made.
- Wires of exactly known diameters are chosen such that they contact the flanks at their straight portions.
- If the size of the wire is such it contacts the flanks at the pitch line, it is called the '**best size**' of wire which can be determined by geometry of screw thread.
- The screw thread is mounted between the centers & wires are placed in the grooves and reading M is taken.
- Then the effective diameter E =T+P
- Where,
- T =M-2d, & P is a value which depends on diameter of wire, pitch & angle of the screw thread.



| | | |
|---|---|---|
| | From the above reading<br>The effective diameter E is calculated by $E = T + P$<br>Where, $T$ = Dimension under the wires = $M - 2d$<br>$M$ = Dimension over the wires<br>$d$ = diameter of each wire<br>If $P'$ = Pitch of thread then<br>$P = 0.9605\,P' - 1.1657d \Rightarrow$ Whitworth thread.<br>$P = 0.866\,P' - d \Rightarrow$ For metric thread.<br>Here, $P$ =The difference between the effective diamet and the diameter under the wires.<br>The diameter under the wires '$T$' also can be determined by<br>$T = S - (R_1 - R_2)$<br>Where, $S$ = The diameter of the standard. | |

| QNO | ANSWER | MARKS |
|---|---|---|
| 11. | **State the advantages and applications of coordinate measuring machine.**<br>**Applications:**<br>• Co-ordinate measuring machines find applications in automobile, machine tool, electronics, space and many other large companies.<br>• These machines are best suited for the test and inspection of test equipment, gauges and tools<br>• For aircraft and space vehicles, hundred percent inspections is carried out by using CMM.<br>• CMM can be used for determining dimensional accuracy of the components.<br>• These are ideal for determination of shape and position, maximum metal condition, linkage of results etc. which cannot do in conventional machines.<br>• CMM can also be used for sorting tasks to achieve optimum pairing of components | |

within tolerance limits.

- CMMs are also best for ensuring economic viability of NC machines by reducing their downtime for inspection results. They also help in reducing cost, rework cost at the appropriate time with a suitable CMM.

**Advantages:**

- The inspection rate is increased.
- Accuracy is more.
- Operator's error can be minimized.
- Skill requirements of the operator are reduced.
- Reduced inspection fix Turing and maintenance cost.
- Reduction in calculating and recording time.
- Reduction in set up time.
- No need of separate go / no go gauges for each feature.
- Reduction of scrap and good part rejection.
- Reduction in off line analysis time.