MACHINE TOOLS LABORATORY

MANUAL
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STEP TURNING AND TAPER TURNING ON LATHE
STEP TURNING AND TAPER TURNING ON LATHE

AIM:
To perform Step turning and Taper turning operations on the given work piece

MATERIAL REQUIRED:
Mild steel rod of 25 mm diameter and 100 mm long.

TOOLS REQUIRED:
Vernier calipers, steel rule, spanner, chuck spanner, and H.S.S. single point cutting tool.

SPECIFICATION OF LATHE:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of bed</td>
<td>1390 mm</td>
</tr>
<tr>
<td>Width of bed</td>
<td>200 mm</td>
</tr>
<tr>
<td>Height of centers</td>
<td>165 mm</td>
</tr>
<tr>
<td>Admit between centers</td>
<td>700 mm</td>
</tr>
<tr>
<td>Lead screw pitch</td>
<td>4TPI</td>
</tr>
<tr>
<td>Power of the motor</td>
<td>1 h.p.</td>
</tr>
</tbody>
</table>

THEORY:
Lathe removes undesired material from a rotating work piece in the form of chips with the help of a tool which is traversed across the work and can be fed deep in work. The tool material should be harder than the work piece and the later help securely and rigidly on the machine. The tool may be given linear motion in any direction. A lathe is used principally to produce cylindrical surfaces and plane surfaces, at right angles to the axis of rotation. It can also produce tapers and bellows etc.
A lathe (shown in fig.) basically consists of a bed to provide support, a head stock, a cross side to traverse the tool, a tool post mounted on the cross slide. The spindle is driven by a motor through a gear box to obtain a range of speeds. The carriage moves over the bed guide ways parallel to the work piece and the cross slide provides the transverse motion. A feed shaft and lead screw are also provided to power the carriage and for cutting the threads respectively.

SEQUENCE OF OPERATIONS:

- Centering
- Facing
- Plain turning
- Chamfering
- Step turning
- Grooving
- Taper turning
PROCEDURE:

• The work piece is fixed in a 3-jaw chuck with sufficient overhang.

• Adjust the machine to run the job to a required cutting speed.

• Fix the cutting tool in the tool post and centering operation is performed so that the axis of the job coincides with the lathe axis.

• Give the feed and depth of cut to the cutting tool

• Facing operation is performed from the center of the job towards outwards or from the circumference towards the center.

• Plain turning operation is performed until the diameter of the work piece reduces to 23 mm.

• Check the dimensions by using vernier calipers.

• Then chamfering is done on the 23mm diameter surface.

• Reverse the work piece in the chuck and facing operation is performed to reduce the length of work piece to the required dimensions.

• Again Plain turning operation is performed until the diameter of the work piece reduced to 18mm.
Using V-cutting tool grooving operation is performed according to the given dimensions and finish the groove using parting tool.

Swivel the compound slide to the required angle and taper turning operation by rotating the compound slide wheel.

The angle can be measured by using the formula \[ \tan \alpha = \frac{D - d}{2L} \]

Finally check the dimensions by using vernier calipers.

**PRECAUTIONS:**

- The work piece should be held rigidly in the chuck before operating the machine.
- Tool should be properly ground, fixed at correct height and properly secured, and work also be firmly secured.
- Before operating the machine see whether the job and tool is firmly secured in devices or not.
- Optimum machining conditions should be maintained.
- Chips should not be allowed to wound around a revolving job and cleared as often as possible
- Apply cutting fluids to the tool and work piece properly.

**RESULT:**
THREAD CUTTING AND KNURLING ON LATHE
AIM:
To perform Thread cutting and Knurling operation on the given work piece.

MATERIAL REQUIRED:
Mild Steel rod of 25 mm diameter and 100 mm long

TOOLS REQUIRED:
Vernier calipers, steel rule, spanner, chuck spanner, and H.S.S. single point cutting tool, parting tool and V- cutting tool.

SPECIFICATION OF LATHE:
- Length of bed: 1390 mm
- Width of bed: 200 mm
- Height of centers: 165 mm
- Admit between centers: 700 mm
- Lead screw pitch: 4TPI
- Power of the motor: 1 H.P.

THEORY:
Lathe removes undesired material from a rotating work piece in the form of chips with the help of a tool which is traversed across the work and can be fed deep in work. The tool material should be harder than the work piece and the later help securely and rigidly on the machine. The tool may be given linear motion in any direction. A lathe is used principally to produce cylindrical surfaces and plane surfaces, at right angles to the axis of rotation. It can also produce tapers and bellows etc.
A lathe basically consists of a bed to provide support, a head stock, a cross side to traverse the tool, a tool post mounted on the cross slide. The spindle is driven by a motor through a gear box to obtain a range of speeds. The carriage moves over the bed guide ways parallel to the work piece and the cross slide provides the transverse motion. A feed shaft and lead screw are also provided to power the carriage and for cutting the threads respectively.

SEQQUENCE OF OPERATIONS:

- Centering
- Facing
- Plain turning
- Chamfering
- Step turning
- Grooving
- Thread cutting
- Knurling
PROCEDURE:

- The work piece is fixed in a 3 – jaw chuck with sufficient overhang.
- Adjust the machine to run the job to required cutting speed.
- Fix the cutting tool in the tool post and centering operation is performed so that the axis of the job coincides with the lathe axis.
- Facing is performed by giving longitudinal depth of cut and cross feed.
- Perform plain turning operation until the diameter of the work piece reduced to 20mm.
- Chamfering operation is done according to the given dimensions.
- Then reverse the work piece in the chuck and plain turning operation is performed according to the given dimensions.
- Using V-cutting tool and parting off tool perform grooving operation to the required dimensions.
- Reduce speed of the spindle by engaging back gear and use Tumbler feed reversing mechanism to transmit power through the lead screw.
• And calculate the change gears for the required pitch to be made on the work piece.

• Using half nut mechanism perform thread cutting operation (right hand threading) according to the given dimensions and continues it until required depth of cut is obtained.

• At the same speed knurling operation is performed using knurling tool.

• For every operation check the dimensions using vernier calipers.

PRECAUTIONS:

• Before starting the spindle by power, lathe spindle should be revolved by one revolution by hand to make it sure that no fouling is there.

• Tool should be properly ground, fixed at correct height and properly secured, and work also be firmly secured.

• Chips should not be allowed to wind around a revolving job and cleared as often as possible.

• Before operating threading operation, V-tool should be properly ground to the required helix angle.

• Apply cutting fluids to the tool and work piece properly.

• No attempt should be made to clean the revolving job with cotton waste.

• On hearing unusual noise, machine should be stopped.

RESULT:
SHAPER

AIM:
To prepare a square block of 22 mm side and 35 mm thick with key way in it from the given work piece by using Shaping machine.

MATERIAL REQUIRED:
M.S. Cylindrical rod of 32 mm diameter and 35 mm length.

TOOLS REQUIRED:
Steel rule, dot punch, Ball peen hammer, surface gauge and scriber, Vernier height gauge, V-block, surface plate and H.S.S.Single point cutting tool.

SPECIFICATION OF THE MACHINE:
Length of ram stroke : 457 mm
Length of ram : 914 mm
Max/min. distance from table to ram 406 x 89
Max. Vertical travel of tool slide 152 mm
Max. Swivel of tool head 60 degrees L & R
Power of the motor 2 H.P.

Theory:
Working Principle
The working principle of a shaper is illustrated in fig1.
In case of shaper; the job is rigidly held in a suitable device like a vice or clamped directly on the machine table. The tool is held in the tool post mounted on the ram of the machine. This ram reciprocates to and fro and in doing so makes the tool to cut the material in the forward stroke. No cutting of material takes place during the return stroke of the ram. Hence it is termed as idle stroke. However in case of a draw cut shaper the cutting takes place in the return stroke and the forward stroke is an idle stroke. The job is given an index feed in a direction normal to the line of action of the cutting tool.

**Principal Parts of a Shaper**

Principal parts of a shaper as illustrated in fig are the following.

1. **Base**: It is a heavy and robust cast iron body which as a support for all the other parts of the machine which are mounted over it.
2. **Column**: It is a box type cast-iron body mounted on the base acts as housing for the operating mechanism of the machine and the electricals. It also acts as a support for other parts of the machine such as cross rail and ram etc.

3. **Cross rail**: It is a heavy cast iron construction attached to the column at its front on the vertical guide ways. It carries two mechanisms: one for elevating the table and the other for cross traversing of the table.

4. **Table**: It is made of cast iron and has a box type construction. It holds and supports the work during the operation and slides along the cross rail to provide feed to the work.

5. **Ram**: It is also an iron casting, semi circular in shape and provides with a ribbed construction inside for rigidity and strength. It carries the tool head and travels in dovetail guide ways to provide a straight line motion to the tool.

6. **Tool head**: It is a device in which is held the tool. It can slide up and down can be swung to a desired angle to set the tool at a desired position for the operation.

7. **Vice**: It is job holding device and is mounted on the table. It holds and supports the work during the operation.

**PROCEDURE**:

![Given Work Piece Diagram with dimensions 35 and Φ32]
• The two ends of the work piece are first smoothened by filing and apply chalk on its surface.
• Place the work piece on the V-block and mark centre on the end face using surface gauge, scriber and Vernier height gauge.
• Mark square on the end face according to the required dimensions.
• By using dot punch made permanent indentation marks on the work piece.
• The tool is fixed to the tool post such that the tool movement should be exactly perpendicular to the table.
• The work piece is then set in the vice such that the tool is just above the work piece.
• Adjust the length of the stroke.
• Make sure that line of action of stroke should be parallel to the surface of the work piece.
• Give depth of cut by moving the tool and feed is given to the work piece during return stroke of the ram.
• Continue the process, until the required dimensions are to be obtained.
• Repeat the process for all the four sides.
• Finally make a key way on one side according to the given dimensions.
PRECAUTIONS:

- Marking should be done accurately.
- The work piece should be set securely and rigidly in the vice.
- Before starting a shaper make sure that the work vise, tool, and ram are securely fastened.
- Check that the tool and tool holder will clear the work and also the column on the return stroke.
- Always stand parallel to the cutting stroke and not in front of it.
- Never attempt to remove chips or reach across the table while the ram is in motion.
- Never attempt to adjust a machine while it is in rotation.
- Suitable feeds and depth of cut should be maintained uniformly.
- Apply cutting fluids to the tool and work piece properly.
- Always feed will be given to the tool in the backward stroke only.

RESULT:
SLOTTING
SLOTTING

AIM:
To Make internal splines, space $90^\circ$ apart on the given hollow cylindrical work piece by using slotting machine.

REQUIRED MATERIAL:
M.S. Hollow Cylindrical work piece of 65 mm diameter and 70 mm length

REQUIRED TOOLS:
H.S.S. Cutting tool, Adjustable wrench, Scriber

SPECIFICATION OF THE MACHINE:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>150 mm</td>
</tr>
<tr>
<td>Rotary table</td>
<td>275 mm</td>
</tr>
<tr>
<td>Longitudinal Movement</td>
<td>200 mm</td>
</tr>
<tr>
<td>Cross Movement</td>
<td>200 mm</td>
</tr>
<tr>
<td>Power of the motor</td>
<td>1 h.p.</td>
</tr>
</tbody>
</table>

THEORY:

A Slotting machine or slotter has its own importance for a few particular classes of work. Its main use is in cutting different types of slots and it certainly proves to be most economical so far as this kind of work is concerned. Its other uses are in machining irregular shapes, circular surfaces and other premarked profiles, both internal as well as external. Its construction is similar to that of vertical shaper. Its ram moves vertically and the tool cuts during the downward stroke only.
Main Parts of a Slotter:

**Base:** It is heavy cast iron construction and is also known as bed. It acts as support for the column, the driving mechanism, ram, table and all other fittings. At its top it carries horizontal ways, along which the table can be traversed.

**Column:** It is another heavy cast iron body which acts as a housing for the driving mechanism. At its front carries vertical ways, along which the ram moves up and down.

**Table:** Usually a circular table is provided on slotting machines. In some heavy duty slotters, either rectangular or circular table can be mounted. On the top of table are provided T-slots to clamp the work or facilitate the use of fixtures etc.

**Ram:** It moves in vertical direction on the guide ways provided in front of the column. At its bottom, it carries the tool post in which the tool is held. The cutting action takes place during the downward movement of the ram.

**PROCEDURE:**

**GIVEN WORK PIECE**

- The tool is fixed to the tool post such that the movement should be exactly perpendicular to the table.
- The work piece is then set in the vice such that the tool is just above the work piece.
- Adjust the length of the stroke of the ram.
Slotting operation is performed and make one slot on the work piece to the required dimensions.

Then bring the tool to the initial position

Rotate the work table by an angle $90^0$ and continue the process for the second slot.

Repeat the process for the remaining slots.

PRECAUTIONS:

- The work piece should be set securely and rigidly in the vice.
- Before starting the machine make sure that the work, vice, tool, and ram are securely fastened.
- Check that the tool and tool holder will clear the work and also clear the column on the return stroke.
- Make sure that the axis of the work piece is parallel to the line of action of tool.
- Never attempt to adjust a machine while it is in motion.
- Suitable feeds and depth of cut should be maintained uniformly.
- Always feed will be given to the work in the backward stroke only.

RESULT:
DRILLING – TAPPING AND SURFACE GRINDING
DRILLING - TAPPING AND SURFACE GRINDING

AIM:
To perform drilling, tapping and surface grinding operations on the given work piece according to the given dimensions.

REQUIRED MATERIAL:
M.S. Flat of 45 x 45 x 10 mm³.

REQUIRED TOOLS:
Vernier height gauge, v-block, Steel rule, dot punch, ball peen hammer and drill bits of diameters 4.5 mm, 8.5 mm & 14 mm and taps of diameter 5mm, 10mm and 16mm.

SEQUENCE OF OPERATIONS:
• Checking the raw material
• Marking and sawing
• Marking on the flat
• Drilling
• Tapping
• Grinding the corners
• Surface grinding

THEORY:
Drilling machine is one of the simplest, moderate and accurate machine tool used in production shop and tool room. It consist of a spindle which imparts rotary motion to the drilling tool, a mechanism for feeding the tool into the work, a table on which the work rests. It is considered as a single purpose machine tool since its chief function is to make holes.
RADIAL DRILLING MACHINE:

Radial drilling machine is intended for drilling medium to large and heavy work pieces. The machine consists of a heavy, round vertical column mounted on a large base. The column supports a radial arm which can be raised and lowered to accommodate work pieces of different heights. The arm may be swung around to any position over the work bed. The drill head containing the mechanism for rotating and feeding the drill is mounted on a radial arm and moved horizontally on the guide ways and clamped at any desired position. These three movements in a radial drilling machine when combined together permit the drill to be located at any desired point on a large work piece for drilling the hole. When several holes are drilled on a large work piece the position of the arm and the drill head is altered so that the drill spindle may be moved from one position to the other after drilling the hole with out altering the setting of the work. This versatility of the machine allows it to work on large work pieces.

Based on the type and number of movements possible the radial drills can be broadly grouped as:

- Plain Radial Drills
- Semi – Universal Radial Drills
- Universal Radial Drills
Surface grinders are primarily intended to machine flat surfaces, although irregular, curved or tapered surfaces can also be ground on them.

**Horizontal spindle reciprocating table surface grinder:** The working principle of the machine is illustrated by means of the diagram of relative movements in fig. A reciprocating table type surface grinder may have a horizontal spindle or a vertical spindle. The former will carry a straight wheel and the latter a cup type wheel. Cutting is done on the periphery of the wheel in case of horizontal spindle and on the revolving edge of the cup wheel on vertical spindle machines. The horizontal spindle machines are widely used in tool rooms. The work piece is usually held on a magnetic chuck on these machines. They are vastly used for grinding flat surfaces. The longitudinal feed to the work is given by reciprocating the table. For giving cross feed there are two methods. One is to mount the table on a saddle and give the cross feed by moving the saddle. Alternatively the cross feed can be given by moving the wheel – head in and out.
PROCEDURE:

Given Work Piece:

Required Work Piece:

All dimensions are in mm.
- The surface of the given work piece is the first smoothened by filing.
- Then chalk is applied on its surface and marking should be done as per the required dimensions.
- Cut the four corners of the work piece by using cold chisel.
- Grind the four corners of the work piece to the required shape by using bench grinder.
- Grind the four sides of the work piece.
- Drilling operation is performed to make different sizes of holes by using drilling machine.

PRECAUTIONS:

- Ensure cooling of work and blade while sawing the work through the supply of proper cutting fluids.
- Use properly sharpened drills for drilling to the right specifications.
- Work piece must be held rigidly on the drilling machine.
- Axis of spindle, adapter, and tool should be coinciding.
- The wheel should be correctly mounted in the spindle and enclosed by a guard.
- The wheel speed chosen should be proper.
- Never grind on the side of a grinding machine.

RESULT:
GRINDING OF SINGLE POINT CUTTING TOOL
SINGLE POINT CUTTING TOOL

ELEMENTS OF A SINGLE POINT TOOL:

**Shank:** It forms the main body of a solid tool and it is this part of the tool which is gripped in the tool holder.

**Face:** It is the top surface of the tool between the shank and the point of the tool. In the cutting action the chip flows along this surface only.

**Corner or point:** It is the wedge shaped portion where the face and flank of the tool meet. It is the cutting part of the tool. It is also called nose

**Flank:** Portion of the tool which faces the work is termed as flank. It is the surface adjacent to and below the cutting edge when the tool lies in horizontal position.

**Base:** It is actually the bearing surface of the tool on which it is held in a tool holder or clamped directly in a tool post.

**Cutting edge:** It is the edge on the face of the tool which removes material from the work piece. The total cutting edge consists of side cutting edge and end cutting edge.

PRINCIPAL ANGLES OF A SINGLE POINT TOOL

**Rake Angle:** It is the angle formed between the face of the tool and a plane parallel to its base. The top face of the tool over which chip flows is known as the rake face. The angle which this face makes with the normal to the machined surface at the cutting edge is known as back rake angle and the angle between the face and a plane parallel to the tool base and measured in a plane perpendicular to both the tool holder and the side cutting edge is known as side
rake angle. 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. When the face of the tool is so ground that it slopes upwards from the point it is said to contain a negative rake. Using negative angles, directs the force back into the body of the tool away from the CE, which gives protection in the CE. The use of negative rake angle increases the cutting force and increases strength of the CE.

**Side cutting angle:** Angle between the side cutting edge and the side of the tool shank. Complimentary angle of SCEA is also called the approach angle. It is the angle which prevents interference as the tool enters the work material.
End cutting Edge angle:
The ECEA provides a clearance or relief to the trailing end of the cutting edge to prevent rubbing or drag between the machined surface and the trailing part of the CE. Only small angle is sufficient for this purpose. An angle of 8° to 15° has been found satisfactory in most cases.

Clearance angle: It is the angle formed by the front or side surfaces 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 surface considered for this purpose is in front of the tool i.e. just below the point, the angle formed is called front clearance and when the surface below the side 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 and that of the side clearance to direct the acting thrust to the metal area adjacent to the cutting edge.

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

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 of the cutting, tip, a prolonged tool life and a superior Surface finish on the work piece. Also as the value of this radius increases, a higher cutting speed can be used. But if it is too large it may lead to chaffer. So a balance has to be maintained.

TOOL AND CUTTER GRINDER:
Tool and Cutter grinders are used mainly to sharpen and recondition multiple tooth cutters like reamers, milling cutters, drills, taps, hobs and other types of tools used in the shop.
With various attachments they can also do light surface, cylindrical, and internal grinding to finish such items as jig, fixture, die and gauge details and sharpen single point tools. They are classified, according to the purpose of grinding into two groups:

- Universal – tool and cutter grinders
- Single – purpose tool and cutter grinders

Universal tool and cutter grinders are particularly intended for sharpening of miscellaneous cutters. Single purpose grinders are used for grinding tools such as drills, tool-bits, etc in large production plants where large amount of grinding work is necessary to keep production tools in proper cutting condition. In addition tools can be ground uniformly and with accurate cutting angles.
### Set Up of Fixtures for Grinding Tool:

<table>
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<tr>
<th>POSITION</th>
<th>SHANK POSITION</th>
<th>ANGLE TO BE GROUND</th>
<th>SWIVEL OF HORIZONTAL BASE</th>
<th>SWIVEL OF VERTICAL BASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Horizontal</td>
<td>End cutting edge angle</td>
<td>10° anti-clockwise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Horizontal</td>
<td>End clearance angle</td>
<td>-----</td>
<td>12° anti-clockwise</td>
</tr>
<tr>
<td>2</td>
<td>Vertical</td>
<td>Back Rake angle</td>
<td>10° clockwise from the right side of the operator</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td>Vertical</td>
<td>Side rake angle</td>
<td>10° clockwise from the operators view</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Vertical</td>
<td>Side cutting edge angle</td>
<td>-----</td>
<td>12° clockwise from the right side of the operator</td>
</tr>
<tr>
<td></td>
<td>Vertical</td>
<td>Side clearance angle</td>
<td>6° anti-clockwise</td>
<td></td>
</tr>
</tbody>
</table>
PLANING MACHINE
Planing is one of the basic operations performed in machining work and is primarily intended for machining large flat surfaces. These surfaces may be horizontal, vertical or inclined. In this way, the function of a planning machine is quite similar to that of a shaper except that the former is basically designed to undertake machining of such large and heavy jobs which are almost impractical to be machined on a shaper or milling, etc. It is an established fact that the planning machine proves to be most economical so far as the machining of large flat surfaces is concerned. However, a palning machine differs from a shaper in that for machining, the work, loaded on the table, reciprocates past the stationary tool in a planer, whereas in a shaper the tool reciprocates past the stationary work.

WORKING PRINCIPLE OF A PLANER:

The principle involved in machining a job on a planer is illustrated in fig. Here, it is almost a reverse case to that of a shaper. The work is rigidly held on the work table or a platen of the machine. The tool is held vertically in the tool-head mounted on the cross rail. The work table, together with the job, is made to reciprocate past the vertically held tool. The indexed feed after each cut is given to the tool during the idle stroke of the table.
SPECIFICATIONS:
Horizontal distance between two vertical housings:
Vertical distance between table top and the cross rail: 800mm
Maximum length of table travel: 1350mm
Length of bed: 2025mm
Length of table: 1425mm
Method of driving – Individual
Method driving table – Geared
H.P. of motor: 3 H.P. & 1 H.P.

STANDARD OR DOUBLE HOUSING PLANER:
This is the most commonly used type of planer. It consists of two vertical housings or columns, one on each side of the bed. The housings carry vertical or scraped ways. The cross-rail is fitted between the two housings and carries one or two tool heads. The work table is mounted over the bed. Some planers may fit with side tool heads fitted on the vertical columns.

MAIN PARTS OF A PLANER
A planer consists of the following main parts as illustrated by means of a block diagram in fig.

- Bed
- Table
- Housings or columns
- Cross – rail
- Tool head
- Controls

These machines are heavy duty type and carry a very rigid construction. They employ high speeds for cutting but the size of work they can handle is limited to the width of their table i.e. the horizontal distance between the columns.
Extremely large and heavy castings, like machine beds, tables, plates, slides, columns, etc., which normally carry sliding surfaces like guide ways or dovetails on their longitudinal faces, are usually machined on these machines. Also because of long table and larger table travel, on either side of the columns, it is possible to hold a number of work pieces in a series over the bed length and machine them together. This will effect a substantial saving in machining time. Further because of no.of tool heads the surfaces can be machined simultaneously. This effects further reduction in machining time. Also because of high rigidity of high rigidity of the machine and robust design of the cutting tools heavier cuts can be easily employed, which leads to quicker metal removal and reduced machining time. Thus an overall picture emerges that the employment of this type of machine apart from its capacity to handle such heavy and large jobs which are difficult to be handled on other machines, leads to faster machining and reduced machining time and hence to economical machining. However considerable time is used in setting up a planer.
DRIVE MECHANISMS:

Four different methods are employed for driving the table of a planer. They are:

- Crank drive
- Belt drive
- Direct reversible drive
- Hydraulic drive

QUICK RETURN MECHANISM FOR PLANER TABLE:

Belt Drive:

Most of the common types of planers carry this system of drive for the quick return of their tables. The main features of this drive are shown in fig.
It consists of the main driving motor situated over the housings. This motor drives the countershaft through an open V-belt. The countershaft, at its extreme carries two driving pulleys; one for open belt and the other for cross belt.

The main driving shaft is provided below the bed. One end of it passes through the housing and carries a pinion, which meshes with the rack provided under the table of the machine as shown. The other end of this shaft carries two pairs of pulleys – each pair consisting of a fast pulley and loose pulley. One of these pairs is connected to one of the driving pulleys by means of a open belt and the other to the second driving pulley by means of a cross belt. A speed reduction gear box is mounted on the main driving shaft and the same is incorporated between the pinion and the pairs of driven pulleys.

One set of the above pulleys is used for the forward motion of the table and the other set for backward or return motion. the cross belt will be used for forward motion and the open belt for return motion. Note that the driving pulley on the counter shaft for cross belt is smaller than the pair of fast and loose pulleys for the same. Against this the driving pulley on the countershaft for open belt is bigger than the pair of fast and loose pulleys for the same. Consequently therefore for the same speed or number of revolutions of the countershaft the main driving shaft will run faster when connected by open belt than when the cross belt is used. It is obvious therefore that the return stroke will be faster than the forward stroke.

It should also be noted here that the pulleys are so arranged that when the cross belt is on the fast pulley, i.e. in forward stroke the open belt will be on the loose pulley and its reverse will take place during the return stroke. In order that this relative shifting of belt may take place automatically at the end of each stroke, without stopping the machine, a belt shifter and its operating lever are provided on the machine. Trip dogs are mounted one each at both ends, on the table. At the end of each stroke these dogs strike against the operating lever alternately and the belt shifted accordingly. Thus the table movement is reversed automatically.
OPERATION DONE ON A PLANER:
The common operations performed on a planer include the following:

• Machining horizontal flat surfaces.
• Machining vertical flat surfaces.
• Machining angular surfaces, including dovetails.
• Machining different types of slots and grooves.
• Machining curved surfaces.
• Machining along premarked contours.

RESULT:
TOOL DYNAMOMETERS
TOOL DYNAMOMETERS

AIM:
To study the Lathe Tool Dynamometer and Drill Tool Dynamometer and determine the Resultant force act on the tool during turning operation and also estimate the force and thrust required to perform drilling operation.

APPARATUS REQUIRED:
Lathe tool Dynamometer and Drill tool dynamometer.

TOOLS & MATERIAL REQUIRED:
HSS tool with tool holder, Φ25mm MS bar, and 10mm thick MS flat and 10mm drill.

THEORY:
In machining or metal cutting operation the device used for determination of cutting forces is known as a Tool Dynamometer or Force Dynamometer. Majority of dynamometers used for measuring the tool forces use the deflections or strains caused in the components, supporting the tool in metal cutting, as the basis for determining these forces. In order that a dynamometer gives satisfactory results it should possess the following important characteristics:

- It should be sufficiently rigid to prevent vibrations.
- At the same time it should be sensitive enough to record deflections and strains appreciably.
- Its design should be such that it can be assembled and disassembled easily.
- A simpler design is always preferable because it can be used easily.
- It should possess substantial stability against variations in time, temperature, humidity etc.
- It should be perfectly reliable.
- The metal cutting process should not be disturbed by it, i.e. no obstruction should be provided by it in the path of chip flow or tool travel.
Types of Dynamometers:

Irrespective of their design and the technique used for strain measurement, most of the force dynamometers used today carry a measuring system which is precalibrated for its stiffness. The cutting forces are measured by these dynamometers by measuring the strain or deflection caused in this system due to the force under measurement. The different types of commonly used dynamometers can be broadly classified as:

- Mechanical dynamometers
- Strain Gauge type dynamometers
- Pneumatic and Hydraulic dynamometers
- Electrical Dynamometers
- Piezoelectric dynamometers

PROCEDURE:

_Lathe Tool Dynamometer:_

Lathe tool dynamometer is used to measure cutting forces acting at the machining zone during turning with a single point cutting tool. All the three directional forces are measured simultaneously.

_Forces on a single point tool in turning:_

In case of oblique cutting in which three component forces act simultaneously on the tool point as shown. The components are:

- $F_t$ = The feed force or thrust force acting in horizontal plane parallel to the axis of the work.
- $F_r$ = The radial force, also acting in the horizontal plane but along a radius of Work piece i.e. along the axis of the tool.
- $F_c$ = The cutting force, acting in vertical plane and is tangential to the work surface. Also called the tangential force.
• The work piece is fixed in a 3-jaw chuck with sufficient overhang.
• Fix the dynamometer cutting tool in the tool post in such away that the tip of the tool coincides with the lathe axis.
• Select proper cutting speed, feed and depth of cut.
• Perform turning operation on the work.
• Directly measure the three components of forces acting on the tool using lathe tool dynamometer.
• Repeat the procedure for varying the above three parameters (CS, F & DC).
• The resultant force can be calculated by

\[ R = \sqrt{F_c^2 + F_f^2 + F_r^2} \]

• Observe the effect of cutting speed, feed and depth of cut on force.

**Drill Tool Dynamometer:**

This is strain gauge Drill Tool Dynamometer designed to measure thrust and torque during drilling operation. This dynamometer is suitable for drilling a hole up to 25mm size in Mild Steel. Drilling tool dynamometer is a Rigid in construction, Compact Unit, Easy in handling and Assessment of cutting forces by giving due consideration to various parameters like depth of cut, material, speed and feed.

**Force system in drilling:**

During the process of drilling a lot of axial pressure (Thrust force) is applied on it in order to make it penetrate into the material. On account of this pressure all the drill elements are subjected to one or other type of force.
The principal forces are:

- **$F_H$** – An equal and opposite horizontal force acting on both lips of the drill and thus neutralizing each other.

- **$F_v$** - Vertical force acting at the centre of the drill in a direction opposite to that of the applied pressure.

- **$F_{v1}$** - Vertical force acting in the same direction as $F_v$, on the lips of the drill it is the main cutting force in the operation.

- **$F_{f1}$** - Frictional force due to rubbing of upward flowing chips against wall of the hole and flutes of the drill.

- **$F_{f2}$** - Frictional force due to rubbing between the drill margin and the hole surface.

- **$P$** – The applied axial pressure or thrust force acting along the axis of drill to press it into the work piece material.

In order that the drill penetrates into the work piece the applied pressure $P$, should be able to overcome all the resistive forces acting against it.

$$P > (F_v + 2F_{v1} + F_{f1} + F_{f2})$$

It is reckoned that as compared to $F_v$ and $F_{v1}$ the magnitudes of the frictional forces $F_{f1}$ and $F_{f2}$ are too small to be considered for practical purposes. Hence they are considered negligible. Therefore $P = F_v + 2F_{v1}$
Thrust force acting on the drill, \( M = C \cdot d^{1.9} \cdot f^{0.8} \) N-mm  
Where \( d \) is the diameter of the drill in mm  
\( f \) is the feed per revolution, mm/rev  
C is a constant depends upon the material to be machined  

For Steel, \( C = 616 \)  
Aluminium alloys, \( C = 180 \)  
Magnesium alloys, \( C = 103 \)  
Brasses, \( C = 359 \)  

Torque acting on the drill is given by \( T = K \cdot d^{0.7} \) N  
For Steel, \( K = 84.7 \)  
Cast Iron = 60.5

- Fix the drill of a particular diameter in the drill chuck.  
- Fix the work piece in vice mounted on the bed of the machine.  
- Attach the drill tool dynamometer to the machine.  
- Perform drilling operation on the work.  
- Note down the values of thrust force and torque acting on the drill directly from drill tool dynamometer.  
- Repeat the procedure by varying the speed, feed and depth of cut of the drill.  
- Observe how these parameters will effects the force and torque.

PRECAUTIONS:  
- The tool should be rigidly mounted on the lathe tool post.  
- Make sure that there should not be any vibrations in the tool.  
- Readings should be noted carefully.  
- Select the cutting speed, feed and depth of cut properly.

RESULT: