JSS MAHAVIDYAPEETHA
SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING
MYSURU-570006

DEPARTMENT OF MECHANICAL ENGINEERING

Machine Shop Manual

V Semester B.E. Mechanical Engineering

USN :____

Name:____

Roll No: ___________ **Sem** ___________ **Sec** _________

Course Name ___________________________________

Course Code

DEPARTMENT OF MECHANICAL ENGINEERING

VISION OF THE DEPARTMENT

Department of mechanical engineering is committed to prepare graduates, post graduates and research scholars by providing them the best outcome based teaching-learning experience and scholarship enriched with professional ethics.

MISSION OF THE DEPARTMENT

M-1: Prepare globally acceptable graduates, post graduates and research scholars for their lifelong learning in Mechanical Engineering, Maintenance Engineering and Engineering Management.

M-2: Develop futuristic perspective in Research towards Science, Mechanical Engineering Maintenance Engineering and Engineering Management.

M-3: Establish collaborations with Industrial and Research organizations to form strategic and meaningful partnerships.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1 Apply modern tools and skills in design and manufacturing to solve real world problems.

PSO2 Apply managerial concepts and principles of management and drive global economic growth.

PSO3 Apply thermal, fluid and materials fundamental knowledge and solve problem concerning environmental issues.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO1: To apply industrial manufacturing design system tools and necessary skills in the field of mechanical engineering in solving problems of the society.

PEO2: To apply principles of management and managerial concepts to enhance global economic growth.

PEO3: To apply thermal, fluid and materials engineering concepts in solving problems concerning environmental pollution and fossil fuel depletion and work towards alternatives.

PROGRAM OUTCOMES (POS)

PO1 **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

MACHINE SHOP PRACTICE

Subject Code	**: ME46L**	**No. of Credits**	**: 0 – 0 - 1.5**
No. of Practical Hours / Week	**: 03**	**CIE Marks**	**: 50**
Total No. of Practical Hours	**: 39**		

COURSE OBJECTIVES:

1. To impart practical and working knowledge of Machine Tools and operations.
2. To develop machining skills with appropriate selection of tools.

COURSE CONTENT

PART – A

Preparation of three models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

PART – B

Cutting of V Groove/ dovetail / Rectangular groove using a shaper. Cutting of Gear Teeth using Milling Machine.

COURSE OUTCOMES:

Upon completion of this course, students should be able to:

CO1 Demonstrate practical and working knowledge of Machine Tools and operations.
CO2 Demonstrate machining skills with appropriate selection of tools.

CO s	CO %	**PO sand PSOs Mapping**														
		PO	PO2	PO	PO4	PO	PO	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		3	3	2	1	3	1	2	1	3	3	2	2	3	1	2
CO2		3	3	2	1	3	1	2	1	3	3	2	2	3	1	2
Total																

CONTENTS

1. MACHINE SHOP

1.1 Introduction to Machine shop

A place where hand tools and power-driven tools are used for making, finishing, or repairing machines or machine parts or in other words a facility that has machines, machine tools for working with metal other relatively hard materials such as some ferrous and non ferrous, composites, polymers, etc,. Various kinds of machine shops make and repair all types of metal objects from machine tools, dies and molds etc.

1.2 Introduction to Machining:

The machining is the broadest technological process used in manufacturing. Generally, in the field of manufacturing, the term of Machining means removal of material from a raw material, by cutting small chips, in order to obtain the desired shape and dimensions for final part. The machining is strictly necessary when finished Part has to have very tight tolerances of Dimensions or when the roughness of surfaces Need to be very smooth.

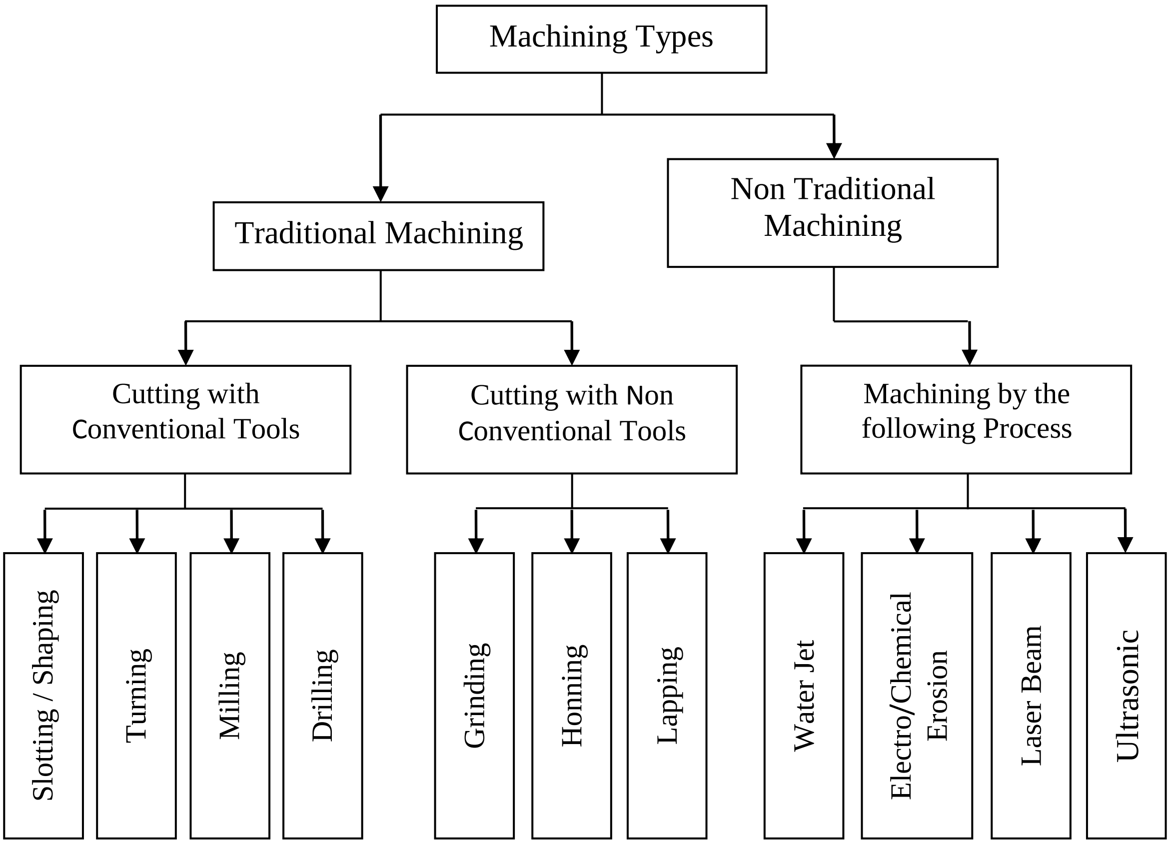


Fig.1 Synoptically Classification

1.3 Machine Tool:

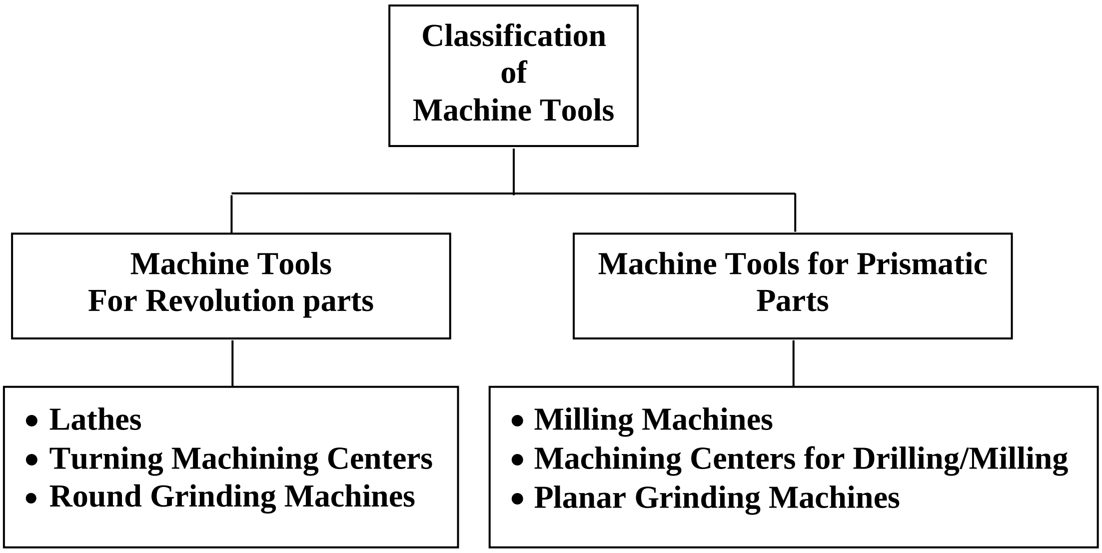
Machine tool is a non-portable power operated device in which the energy is utilized to produce jobs of desired shape and size and surface finish by removing excess material from the formed blanks in the form of chips with the help of cutting tools moved part the work surface.

It is machining equipment that cuts, shears, punches, presses, drills, rolls, grinds, sands, or forms metal, plastic, or wood stock. It may be automatic or semi-automatic.

Machine tools are generally power- driven metal cutting or forming machines used to shape metals by:

- The removal of chips

- Pressing drawing or shearing
- Controlled electrical machining process
- Any machine tool has generally has capability of
- Holding and supporting the work piece
- Holding and supporting a cutting tool
- Imparting a suitable movement (rotating or reciprocating) to the cutting tool or the work
- Feeding the cutting tool so that the desired cutting action and accuracy will be achieved
- The performance of any machine toolis generally stated in terms of its metal removal rate, accuracy and repeatability.



1.4 Cutting Tool

A tool is a device or a piece of equipment which typically provides a mechanical advantage in accomplishing a physical task, or provides an ability that is not naturally available to the user of a tool. These tools are hand-held, portable powers, or manual tools.

The differences are stated below:

Cutting Tools	**Machine Tools**
1. Tool is a portable device 2. Tool is a non-powered device 3. Tool can only powered by humans **Examples:** Turning, shaping, drilling, milling tools, Hammers, wrenches, saws and shovels, pens, pencils and knives are tools.	1. It is a stationary device 2. It is a powered device 3. It is powered by a power source or by people if properly setup. **Examples:** Lathes, shapers, planers, power drills or drill presses, milling machines, grinding machines, power saws, and presses (e.g., punch presses).

1.5 Tool Materials

The various tool materials used in today's manufacturing operations are high-carbon steel, high-speed steel, cemented carbides, ceramics, diamond & cubic boron nitride (CBN).

Types of Tool Materials:

- ✓ High Carbon steels
- ✓ High Speed Steels
- ✓ Cemented Carbides
- ✓ Medium Alloy steels
- ✓ Abrasives
- ✓ Diamonds
- ✓ Stellite Ceramics

1.5.1 High Carbon Steel

This material is one of the earliest cutting materials used in machining. It is however now virtually superseded by other materials used in engineering because it starts to temper at about 220ºC. This softening process continues as the temperature rises. As a result cutting using this material for tools is limited to speeds up to 0.15 m/s for machining mild steel with lots of coolant. High carbon steels are oil- or water-hardened plain carbon steels with 0.9 to 1.4 percent carbon content. They are used for hand tools such as files and chisels, and only to a limited extent for drilling & turning tools. They impart such properties to tools made from them that such tools maintain a keep edge & can be used for metals that can be used for such metals that produce low tool-chip interface temperatures-for example, aluminum, magnesium, copper, and brass. These tools, however, tend to soften at machining speeds above 50 feet per minute (fpm) in mild steels.

1.5.2 High Speed Steel (HSS)

This range of metal contains about 7% carbon, 4% chromium plus additions of tungsten, vanadium, molybdenum and cobalt. These metals maintain their hardness at temperature up to about 600, but soften rapidly at higher temperatures. These materials are suitable for cutting mild steel at speeds up maximum rates of 0.8 m/s to 1.8 m/s. High-speed steel may be used at higher cutting speeds (100 fpm in mild 20 steels) without losing their hardness. High-speed steel is sometimes used for lathe tools when special tool shapes are needed, especially for boring tools. However, high-speed steel is extensively used for milling cutters. These cutters usually have a longer working life.

1.5.3 Cast Alloys

These cutting tools are made of various nonferrous metals in a cobalt base. They can withstand cutting temperatures of up to 760oC and are capable of cutting speeds about 60% higher than HSS.

1.5.4 Stellite

This is a cast alloy of Co (40 to 50%), Cr (27 to 32%), W (14 to 19%) and C (2%). Stellite is quite tough and more heat and wear resistive than the basic HSS (18 – 4 – 1) But such stellite as cutting tool material became obsolete for its poor grindability and especially after the arrival of cemented carbides.

1.5.5 Cemented carbides (Cermets or Sintered Carbide)

Carbide, generally, is a chemical compound of carbon and a metal. This material usually consists of tungsten carbide or a mixture of tungsten carbide, titanium, or tantalum carbide in powder form, sintered in a matrix of cobalt or nickel. The term Carbide is commonly used to re-present to cemented carbides, the cutting tools composed of tungsten carbide, titanium carbide, or tantalum carbide & cobalt in various combinations. A typical composition of cemented carbide is 85 to 95 percent of tungsten & the remainder a cobalt binder for the tungsten carbide powder. Cemented carbides are extremely hard tool materials (above RA 90), have a high compressive strength & resist wear & rupture. Coated carbide inserts are often used to cut hard or difficult-to-machine work pieces. Titanium carbide (TiC) coating offers high wear resistance at moderate cutting speeds and temperatures. Aluminum oxide (Al_2O_3) coating has high resistance to crater wear and reduces friction between the tool face and the chip, thereby reducing the tendency for built-up edge.

Cemented carbides are the most widely used tool materials in the machining industry. They are particularly useful for cutting tough alloy steels, which quickly break down high-speed tool steels. As this material is expensive and has low rupture strength it is normally made in the form of tips which are brazed or clamped on a steel shank. The clamped tips are generally used as throw away inserts.

1.5.6 Coated Carbides

The cutting system is based on providing a thin layer of high wear-resistant titanium carbide fused to a conventional tough grade carbide insert, thus achieving a tool combining the wear resistance of one material with the wear resistance of another. These systems provide a longer wear resistance and a higher cutting speed compared to conventional carbides.

1.5.7Ceramics

Ceramic or “cemented oxide” tools are made primarily from aluminum oxide. Ceramics are made by powder metallurgy from aluminium oxide with additions of titanium oxide and magnesium oxide to improve cutting properties. Some manufacturers add titanium, magnesium, or chromium oxides in quantities of 10% or less. The tool materials are molded at pressures over 4000 psi and sintered at temperatures of approximately 3000$_0$F. This process partly accounts for the high density and hardness of cemented oxide tools. These have a very high hot resistance and wear resistance and can cut at very high speed. However they are brittle and have little resistance to shock. Their use is therefore limited to tips used for continuous high speed cutting on vibration-free machines. Cemented oxides setups are rigid and free of vibration and are used as a replacement for carbide tools that are wearing rapidly, but not to replace carbide tools that are breaking.

1.5.8 Diamonds Tools

Diamonds have limited application due to the high cost and the small size of the stones. They are used on very hard materials to produce a fine finish and on soft materials especially those inclined to clog other cutting materials. They are generally used at very high cutting speed with low feed and light cuts. Due to the brittleness of the diamonds the machine has to be designed to be vibration free. The tools last for 10 (up to 400) times longer than carbide based tools. Industrial diamonds are sometimes used to machine extremely hard work pieces. Only relatively small removal rates are possible with diamond tools, but high speeds are used and good finishes are obtained. Diamond tools are particularly effective for cutting abrasive materials that quickly wear out other tool materials. Nonferrous metals, plastics, and some nonmetallic materials are often cut with diamond tools.

1.5.9 Cubic Boron Nitride (CBN)

CBN is next to diamond in hardness and therefore can be used to machine plain carbon steels, alloy steels, and gray cast irons with hardness’s of 45 RC and above. CBN inserts consist of a cemented carbide substrate with an outside layer of CBN formed as an integral part of the tool. Tool life, finishes, and resistance to cracking and abrasion make CBN a superior tool material to both carbides and ceramics.

1.5.10 Abrasive:

Abrasive grains in various forms loose bonded into wheels and stone and embedded in papers and cloths find wide application in industry. They are mainly used for grinding harder materials and where a superior finish is desired on hardened or unhardened materials.

1.5.11 Elements of an Effective Tool:

- ✓ High hardness at elevated temperatures
- ✓ Strength to resist bulk deformation
- ✓ Adequate thermal properties
- ✓ Consistent tool life
- ✓ Wear resistance
- ✓ Consistent tool life
- ✓ Correct geometry
- ✓ Chemical stability

1.5.12 There are 2 types of cutting tools

a)Single Point Cutting Tool:

The tool generally refers to a non-rotary cutting tool used in metal lathes, shapers, and planers. Such cutters are also often referred to by the set-phrase name of single-point cutting tool. The cutting edge is ground to suit a particular machining operation and may be resharpened or reshaped as needed. The ground tool bit is held rigidly by a tool holder while it is cutting. Single-point tools are used in turning, shaping and planning operations and similar operations to remove material by means of one cutting edge.

Cutting tools must be made of a material harder than the material which is to be cut, and the tool must be able to withstand the heat generated in the metal-cutting process. Also, the tool must have a specific geometry, with clearance angles designed so that the cutting edge can contact the work piece without the rest of the tool dragging on the work piece surface. The angle of the cutting face is also important, as is the flute width, number of flutes or teeth, and margin size. In order to have a long working life, all of the above must be optimized, plus the speeds and feeds at which the tool is run.

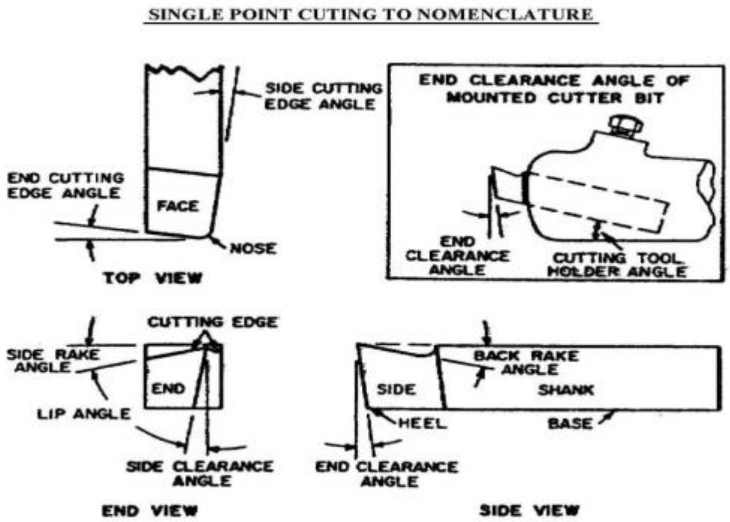


Fig.2 Showing parts &important angles cut on single point cutting tool

<u>Single point cutting tool terms and definitions:</u>

(1) Shank: The shank is the main body of the tool.

(2) Nose: The nose is the part of the cutter bit which is shaped to produce the cutting edges.

(3) Face: The face of the cutter bit is the surface at the upper side of the cutting edge on which the chip strikes as it is separated from the workpiece.

(4) Side: The side of the cutter bit is the near-vertical surface which, with the end of the bit, forms the profile of the bit. The side is the leading surface of the cutter bit used when cutting stock.

(5) Base: The base is the bottom surface of the shank of the cutter bit.

(6) End: The end of the cutter bit is the near-vertical surface which, with the side of the bit, forms the profile of the bit. The end is the trailing surface of the cutter bit when cutting.

(7) Heel: The heel is the portion of the cutter bit base immediatelybelow& supporting the face.

Important angles of a Single Point Cutting Tool:

Angle	Details
Back Rake Angle	It is also called as Top Rake Angle. It is the slope given to the face or the surface of the tool. This slope is given from the nose along the length of the tool.
Side Rake Angle	It is the slope given to the face or top of the tool. This slope is given from the nose along the width of the tool. The rake angles help easy flow of chips
Relief Angle	These are the slopes ground downwards from the cutting edges. These are two clearance angles namely, side clearance angle and end clearance angle. This is given in a tool to avoid rubbing of the job on the tool.
Cutting Edge Angle	There are two cutting edge angles namely side cutting edge angle and end cutting edge angle. Side cutting edge angle is the angle, the side cutting edge makes with the axis of the tool. End cutting edge angle is the angle, the end cutting edge makes with the width of the tool.
Lip Angle	It is also called cutting angle. It is the angle between the face and end surface of the tool.
Nose Angle	It is the angle between the side cutting edge and end cutting edge.

Tool Signature

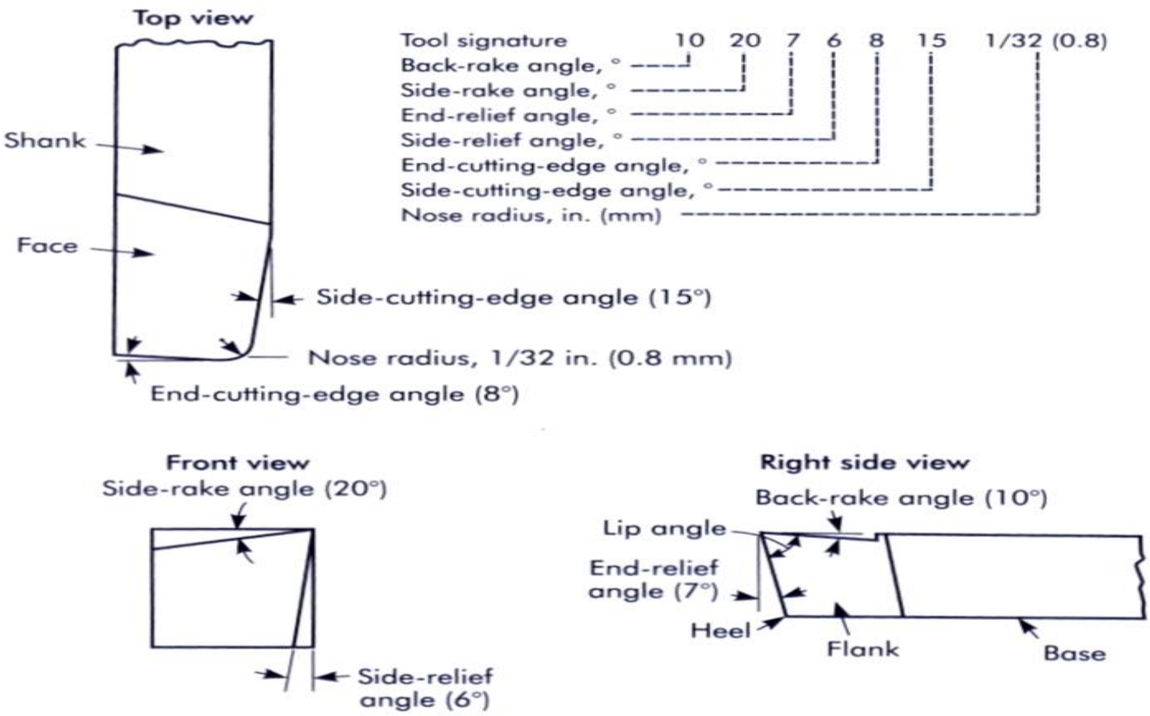


Fig.3 Tool Signature of Single Point Cutting Tool

Shapes of Tool Bits

The overall shape of the lathe tool bits can be rounded, squared, or another shape as long as the proper angles are included. Tool bits are identified by the function they perform, such as turning or facing. They can also be identified as roughing tools or finishing tools. Generally, a roughing tool has a radius ground onto the nose of the tool bit that is smaller than the radius for a finishing or general purpose tool bit. Experienced machinists have found the following shapes to be useful for different lathe operations.A right-hand turning tool bit is shaped to be fed from right to left.

The cutting edge is on the left side of the tool bit and the face slopes down away from the cutting edge. The left side and end of the tool bit are ground with sufficient clearance to permit the cutting edge to bear upon the work piece without the heel rubbing on the work. The right-hand turning tool bit turning tool bit is ideal for taking light roughing cuts as well as general all- around machining. The round-nose turning tool bit is very versatile and can be used to turn in either direction for roughing and finishing cuts. No side rake angle is ground into the top face when used to cut in either direction, but a small back rake angle may be needed for chip removal. The nose radius is usually ground in the shape of a half-circle with a diameter of about 1/32 inch. A left-hand turning tool bit is the opposite of the right-hand turning tool bit, designed to cut when fed from left to right. This tool bit is used mainly for machining close in to a right shoulder.

The right-hand facing tool bit is intended for facing on right hand side shoulders and the right end of a work piece. The cutting edge is on the left-hand side of the bit and the nose is ground very sharp for machining into a square corner. The direction of feed for this tool bit should be away from the center axis of the work, not going into the center axis. A left-hand facing tool bit is the opposite of the right-hand facing tool bit and is intend to machine and face the left sides of shoulders.

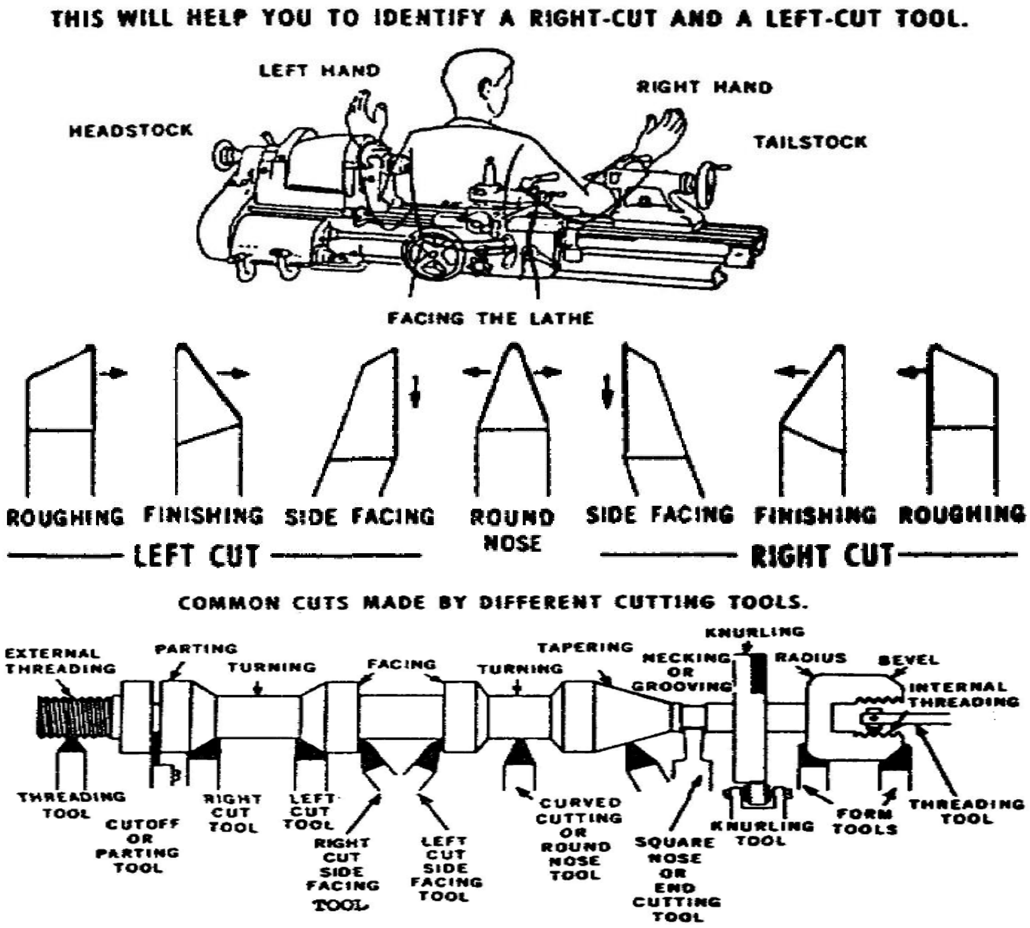


Fig. 3 Left – Hand & Right-hand Cutting tools

1.5.13 Multi Point Cutting Tool

Fig.4 Multipoint cutting tools

In multi point cutting tool the multiple edges are used to remove the material. Multi point cutting tools are used in Milling, drilling, reamers, slotting tool, wood ruff cutter, etc. most important thing to remember is the cutting tools must be made of a material harder than the material which is to be cut, and the tool must be able to withstand the heat generated in the metal-cutting process. Grinding tools are also multipoint tools. Each grain of abrasive functions as a microscopic single-point cutting edge

A multi-point cutting tool is regarded as a series of two or more cutting elements (chip producing elements) secured to a common body. The term such as face, flanks, and cutting edge, defined earlier for single-point tools, are applicable to multi-points tool as well. The commonly used multi-point cutting tools are drills, reamers, milling cutters, broaches, wood ruff cutter, reamers, etc.

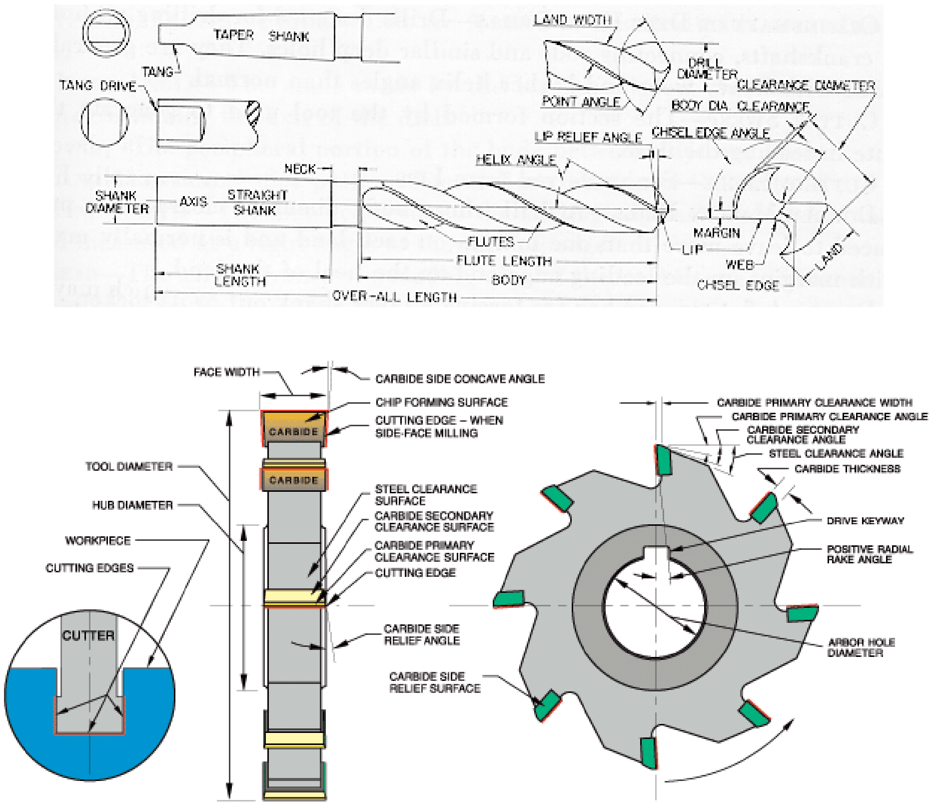


Fig.5Showing parts & important angles of Multi Point Cutting Tools

1.6 ORTHOGANAL CUTTING (Two Dimensional Cutting)

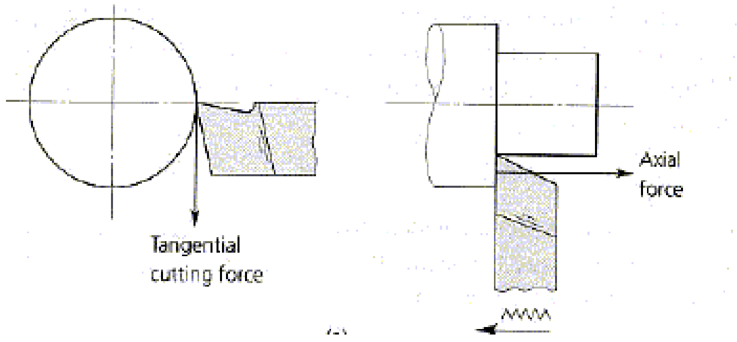


Fig.6 Orthogonal Cutting

1.7 OBLIQUE CUTTING (Three Dimensional Cutting)

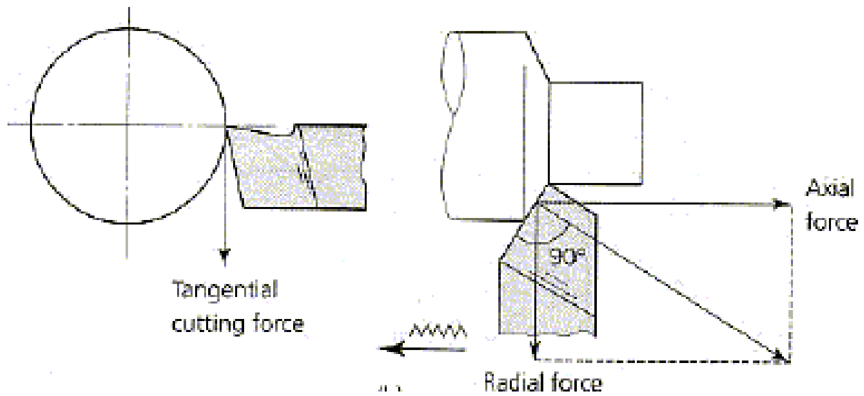


Fig.7 Oblique Cutting

Orthogonal Metal Cutting	Oblique Metal Cutting
Cutting edge of the tool is perpendicular to the direction of tool travel.	The cutting edge is inclined at an angle less than 90° to the direction of tool travel.
The direction of chip flow is perpendicular to the cutting edge.	The chip flows on the tool face making an angle.
The chip coils in a tight flat spiral	The chip flows sideways in a long curl.
For same feed and depth of cut the force which shears the metal acts on a smaller area. So the life of the tool is less.	The cutting force acts on larger area and so tool life is more.
Produces sharp corners.	Produces a chamfer at the end of the cut
Smaller length of cutting edge is in contact with the work.	For the same depth of cut greater length of cutting edge is in contact with the work.
Generally parting off in lathe, broaching and slotting operations are done in this method.	This method of cutting is used in almost all machining operations.

1.8 Cutting Fluids:

Cutting fluids are used in metal machining for a variety of reasons such as improving tool life, reducing work piece thermal deformation, improving surface finish and flushing away chips from the cutting zone.

1.8.1 Types of cutting fluids:

Practically all cutting fluids presently in use fall into one of the four categories:

1. **Cutting Oils**
   a. Straight oils
   b. Compounded
2. **Water Base Cutting Fluids**
   a. Soluble oils
   b. Chemical (Synthetic) fluids
   c. Semi- Chemical (Semi-Synthetic) fluids
3. **Gases**
4. **Paste & Solid Lubricants**

1.8.2 Functions of cutting fluids:

1. Reduce friction between tool & material
2. Reduce temperature of cutting zone
3. Wash away chips
4. Improve surface finish
5. Reduce power required
6. Increase tool life
7. Prevent welding of chip to tool
8. Prevent corrosion

1.8.3 Desired Properties of Cutting Fluids:

1. Harmless to the operator
2. Harmless to the machine
3. Good heat transfer characteristics
4. Non-Volatile
5. Non-forming
6. Good lubricating properties
7. Inexpensive

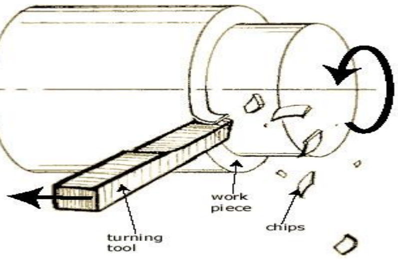
2. LATHE

2.1 Introduction

A lathe is a machine tool which spins a block of material to perform various operations such as cutting, sanding, knurling, drilling, etc. or deformation with tools that comes in contact with the work piece to create an object which has symmetry about an axis of rotation. Lathes are used in woodturning, metalworking, metal spinning, and in glass working. Lathes can be used to shape pottery as well. Most suitably metalworking lathes can be used to produce most solids of revolution, plane surfaces and screw threads or helices. 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. Ornamental lathes can produce three-dimensional solids of incredible complexity. Machine shop personnel must be thoroughly familiar with the lathe and its operations to perform various tasks.

2.2 Principal of Operations

The lathe is a machine tool used principally for shaping articles of metal (and sometimes wood or other materials) by causing the work piece to be held and rotated by the lathe while a tool bit is advanced into the work causing the cutting action. The basic lathe that was designed to cut cylindrical metal stock has been developed further to produce screw threads, tapered work, drilled holes, knurled surfaces, etc. The typical lathe provides a variety of rotating speeds and a means to manually and automatically move the cutting tool into the work piece.



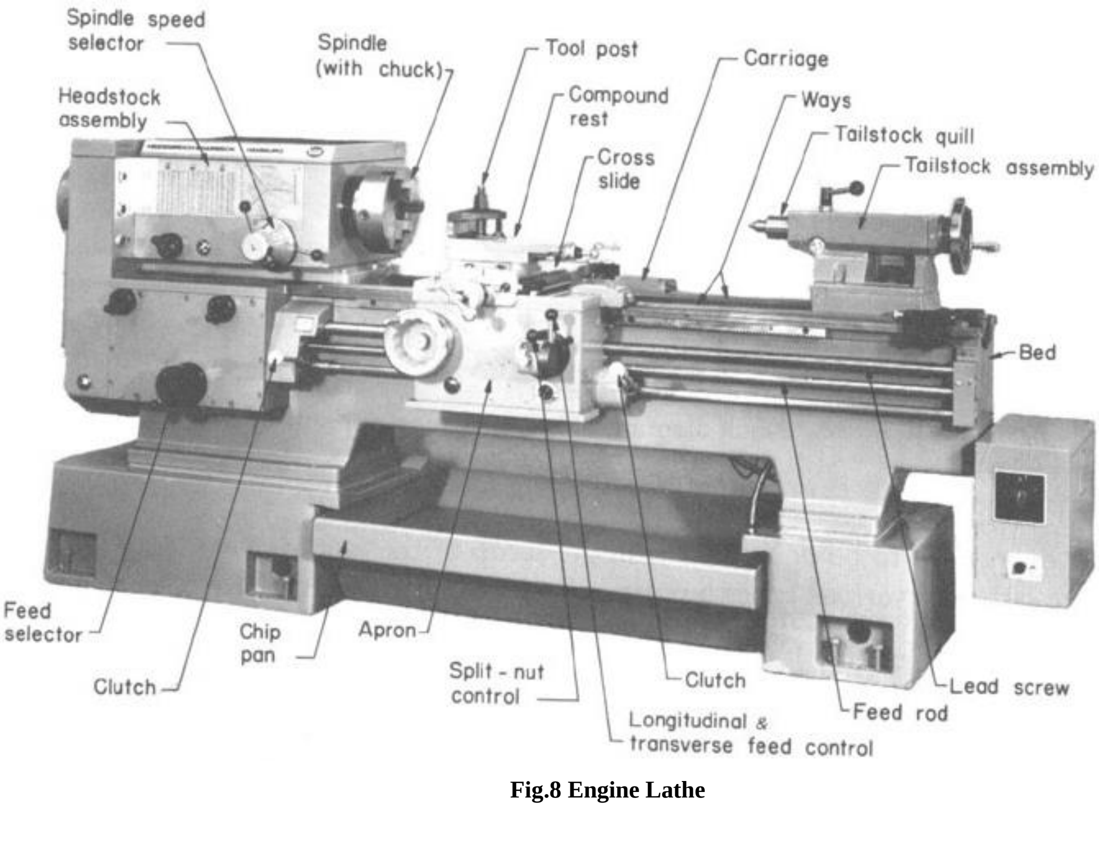


Fig.8 Engine Lathe

2.3 Lathe and its Parts

Headstock	Contains the spindle in two preloaded ball bearings
Spindle	The spindle is inside the headstock and is driven with a belt running from the motor pulley to a pulley on the rear end of the spindle shaft. The nose of the spindle is treaded on the outside to receive chucks and tapered on the inside to receive other accessories.
Chucks	A 3-jaw or 4-jaw chuck threads onto the spindle nose to hold your work, a drill chuck are used on the tailstock to center drill your part.
Tool Post	Attaches to the lathe table and holds a 1/4" square cutting tool
Cross Slide Table	Also sometimes spelled "cross slide," it is the table with two T-slots that holds the tool post.
Cross Slide Gib	A tapered plastic wedge that is held in place by a gib lock. It fits between the angled surfaces of the dovetail and is used to adjust for wear. As wear occurs and the table develops "slop," the lock is loosened and the gib is pushed further into the gap, taking up any play. This allows the machine to always be kept in peak adjustment.
Tail Stock spindle	Has a #0 Morse internal taper for holding chucks and other tools. A hand wheel moves it in and out for drilling
Tail Stock Locking Screw	Locks the tailstock in place on the bed to keep it from moving. When loosened, the tailstock can be slid up and down the bed.
Bed	The dovetailed steel bar that the saddle and tailstock are moved back and forth on.
Saddle	The part that supports the cross slide table and is moved up and down the bed using the lead screw hand wheel.
Saddle Gib	Functions like the cross slide gib to keep the saddle in tight adjustment against the dovetailed bed.
Lead Screw	The threaded screw under the bed that controls movement of the saddle. A "saddle nut" underneath attaches the bed to the leadscrew. Turning the lead screw hand wheel moves the saddle down the bed.
Tail Stock Gib	A brass part attached to the base of the tailstock that runs on one of the bed dovetails. The brass part is expected to wear rather than the more expensive bed and can be adjusted for tightness as it wears.
Lathe Base	The cast metal base upon which the lathe bed and headstock sit.
Drawbolt	Goes through the hole in the spindle to draw chucks and other accessories into the headstock taper inside the spindle. A special washer locates it on center in the spindle hole.

#1 Morse Arbor	The tailstock drill chuck normally has a #0 Morse arbor threaded into the back of it for use in the tailstock spindle. That arbor can be removed and replaced with the #1 Morse arbor so the drill chuck can be used in the headstock.
Dead Centers	#1 and #0 Morse arbors have a 60° point and are used to locate and hold work "between centers" on the lathe. The #1 Morse arbor rotates with the headstock, but because the tailstock spindle does not rotate, the rear #0 Morse arbor is called a "dead" center. This needs to be kept lubricated because it creates friction with the moving part it is locating. Most machinists eventually replace this with a "live" center that turns on a ball bearing.
Tommy Bars	Round steel bars used to tighten and loosen chucks and other spindle accessories. Sometimes called "Spindle Bars."
Faceplate	A cast plate that threads onto the spindle nose. A work piece can be bolted to it as an alternative to using a chuck. It has three slots to drive a drive dog.
Drive Dog	Also called a "Lathe Dog," this part is attached to a piece of bar stock by means of a screw that goes through the side and the long point is placed into one of the slots in the faceplate. The part is located between the lathe centers (live or dead) and when the faceplate turns, the dog actually drives the piece to rotate it for cutting. It also acts as a universal joint when turning a part between centers when the headstock is rotated to a slight angle, allowing a tapered part to be cut.
Head Stock Locking Screw	Holds the headstock in place. The screw is a pointed set screw. The point engages a tapered groove in the pin that sticks up out of the lathe bed. When the screw is tightened, it pulls the headstock down onto the alignment key and holds it tight against the lathe bed.
Alignment Key	A precision ground key that fits in slots in the top of the bed and bottom of the headstock to keep the headstock aligned straight with the tailstock. Removing this key and rotating the headstock allows tapers to be cut.
V-belt	A Kevlar-reinforced Urethane belt that drives the spindle by means of the pulleys.
2-Position Pulley	The motor turns a maximum of about 6000 RPM. Putting the drive belt in the normal (rear) position gears the motor down about 2:1 for a maximum speed of about 2800 RPM. The "High Torque" position (closest to the headstock) gears it about 4:1 for lower speed but more torque when needed for heavy cuts.
Variable Speed Control Knob	Controls motor speed from 0 to 2800 RPM

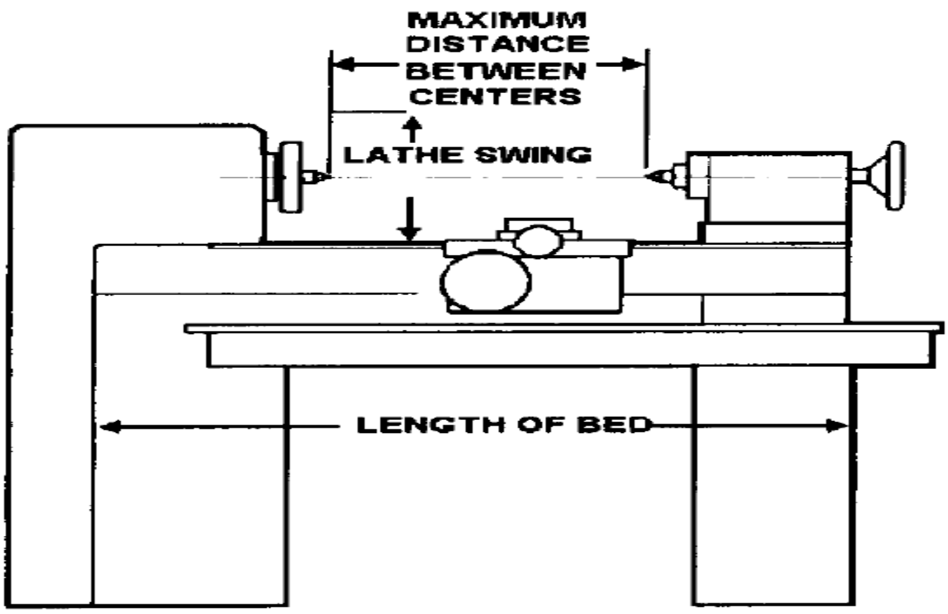
2.4 Lathe Dimensions

Lathe size is determined by the swing and length of bed. Swing indicates the largest diameter that can be turned over the ways (flat or v-shaped bearing surface that aligns and guides moveable parts of machines). Bed length is entire length of the ways. Bed length must not be mistaken for the maximum length of the work that can be turned between centers.

The longest piece that can be turned is equal to the length of the bed minus the distance taken up by the headstock and tailstock.

When comparing the size and working capacities of metal lathes there are several key dimensions to consider:

Fig.9



Dimensions of Lathe

Swing over bed:

The diameter of the largest workpiece that can be rotatedon the spindle without hitting the bed. This is the first ofthe two numbers used to describe the size of a metallathe.

Distance between Centers:

The longest piece of work that can be held between acenter in the headstock and a center in the tailstock. (Seeglossary below for more information). This is the secondof the two numbers used to describe the lathe size.

Swing over the Carriage:

The diameter of the largest workpiece that can rotate overthe carriage without hitting it. On the 9x lathes this isabout 5"

Diameter of Spindle through hole:

The diameter of the hole that passes through the spindle.On the 9x lathes (or any lathe having a #3 Morse Taperspindle) it is about 3/4". When facing relatively long stock,the free end of the stock can pass through the spindle if itis no larger than the through-hole diameter.

2.5 Types of Lathes:

1. **Engine Lathe**
   The most common form of lathe, motor driven and comes in large variety of sizes and shapes.
2. **Bench Lathe**
   A bench top model usually of low power used to make precision machine small work pieces.
3. **Tracer Lathe**
   A lathe that has the ability to follow a template to copy a shape or contour.
4. **Automatic Lathe**
   A lathe in which the work piece is automatically fed and removed without use of an operator. Cutting operations are automatically controlled by a sequencer of some form.
5. **Turret Lathe**
   Lathes which have multiple tools mounted on turret either attached to the tailstock or the cross-slide, which allows for quick changes in tooling and cutting operations.
6. **Computer Controlled Lathe**
   Highly automated lathes, where cutting, loading, tool changing, and partunloadingare automatically controlled by computer coding.

2.6 Machining Parameters:

Cutting Speed:

The speed in surface feet per minute or meters per minute at which the metal may be machined efficiently

Lathe Cutting Speed:

It may be defined as the rate at which a point on the work circumferences travels past the cutting tool. When work is machined in a lathe, it must be turned at a specific number of revolutions per minute(r/mint), depending on its diameter, to achieve the proper cutting speed.

Cutting speed is always expressed in feet per minute (ft/mint) or in meters per minute (m/mint).

Lathe Feed:

The feed of a lathe may be defined as the distance the cutting tool advances along the length of work for every revolution of spindle.

Feed of the lathe is dependent on the speed of the lead screw or feed rod. Speed is controlled by the change gears in the quick – change gear box.

Cutting Speed:

Cutting speed is how fast the metal comes into contact with the tool at thecutting point. On a lathe, it is the rate at which the surface of the job passesthe cutting tool. This takes into account the diameter of the job.The general formula for a cutting speed is as follows:

Feed:

The feed of a lathe may be defined as the distance the cutting tool advances along the length of the work for every revolution of the spindle.

2.7 Various operations performed on Lathe machine

Turning	:	Produces straight, conical, curved, or grooved work pieces
Facing	:	Produces a flat surface at the end of the part
Boring	:	To enlarge a hole
Drilling	:	To produce a hole
Cutting off	:	To cut off a work piece
Threading	:	To produce threads
Knurling	:	Produces a regularly shaped roughness
Profiling	:	To turn cylindrical work pieces with rough and finished cuts
Grooving	:	To make furrows or channels

2.8 Operations on a Lathe:

Turning:
cutting tool is moved parallel to the axis of the work piece to produce a cylindrical surface by removing the unwanted material in the form of chips. Here depth of the cut is given by moving the tool perpendicular to the lathe axis.

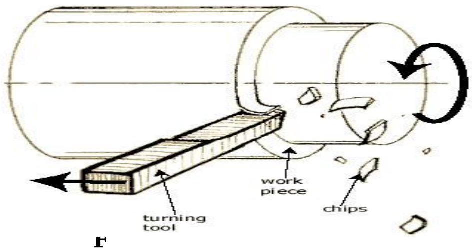


Fig.10 Plain Turning

Facing:
It is an operation to produce flat surface on the ends of the work piece.Here the cutting tool is fed against the rotating work piece perpendicular to the lathe axis and the depth of the cut is given by moving the tool parallel to the lathe axis.

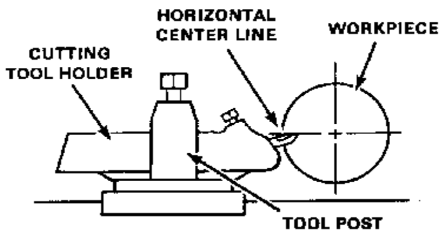


Fig.11 Facing operation

Taper Turning :
It is an operation to produce conical surface on the work piece.
Methods for taper turning.

- ✓ By swivelling the compound rest
- ✓ By offsetting the tail stock
- ✓ By taper turning attachment
- ✓ By using form tool

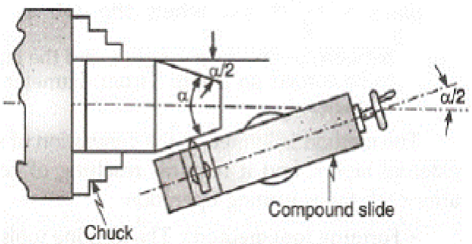
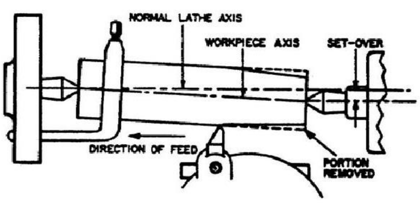


Fig.12 Swivelling of Compound Rest



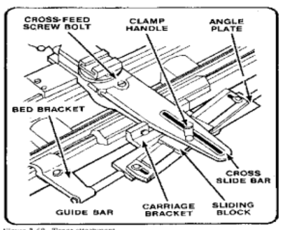
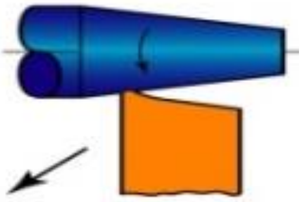


Figure 7-69. Taper attachment.

Fig.13 Using Offsetting the Tail stock

Fig.14 Using Taper Turning Attachment

ig.15 Using Form



Tool

Thread Cuting:

A thread is a helical groove formed on a cylindrical surface of the work piece. The shape of the groove will be normally v or shape which are called as vee- thread or squarThread cutting cannot be done in single pass. It will be carried out in many passes with incremental depth, till the required thread is formed. A typical thread cutting operation is shown in the figure. Thread cutting can be performed both on external and internal surfaces.

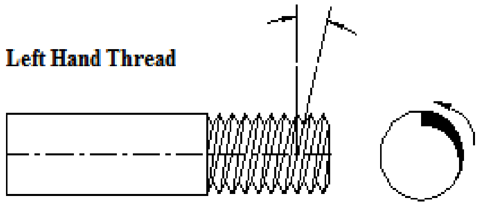


Fig. Left Hand Tread curring

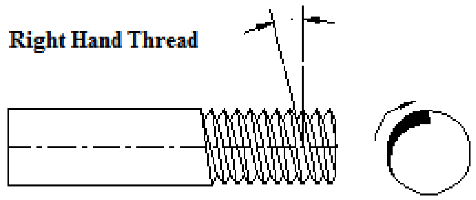
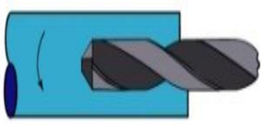


Fig. Right Hand Treaad cutting

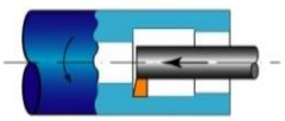
Fig.16 Threading Operations

Drilling:

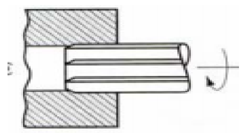
Drilling operation is performed by fixing twist drill bit on the tail stock and advancing the tool towards the workpiece and making hole to the desired length. Other operations like Boring, Centre Drilling, Counter Boring, Counter Sinking, Reaming, Tapping, etc can also be performed using suitable tools



Drilling



Borling

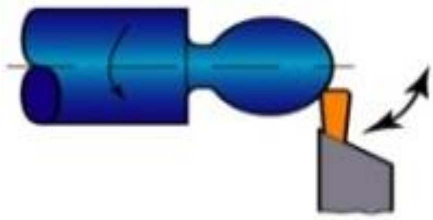


Reaming

Fig.17 Types of Drilling operations performed on Lathe Machine

Profile Turing:

Profile turning is performed when curve surfaces are required on the given job. The skills of the operator plays a very important role as this operation is very difficult to be performed. Here carriage assembly and



compound rest are simultaneously moved to get the given profile.

Fig.18 Profile Turning

Parting/Cutting Off/slotting/grooving operation:
This operation is used to cutoff the finished part from the lengther workpiece or to make groove on the workpiece. Flat cutting tool is used for this opeartion.

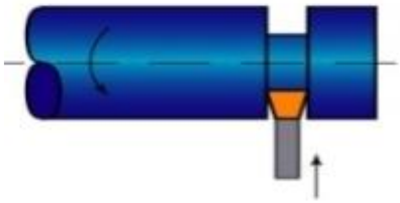


Fig.19 Profile Turning

Forming Opeartion:
A tool which is in the shape of the impression to be made on the work piece is fixed to the tool post and is advanced towards the work piece. This operation saves time and is costly.

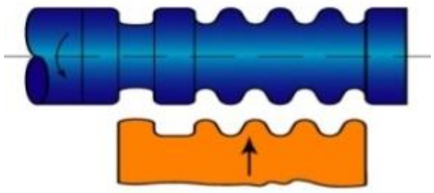


Fig.20 Forming Operation

Knurling Operation:
Knurling is an operation performed on the lathe to generate serrated surface on the work piece. This is used to produce a rough surface for griping like the barrel of the micrometer.
This is done by a special tool called knurling tool. Which has a set of hardened roller with the desired serrations.There are 3 different knurling operations such as diamond, angled and straight.

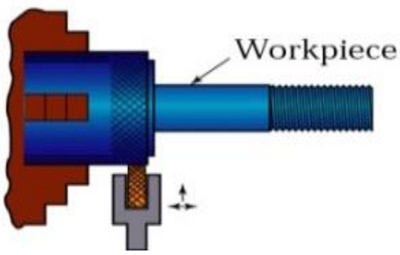


Fig.21 Knurling Operation

2.9 Work Holding Devices

The self-centering chuck (3 – Jaw Chuck)
This is the most convenient and most used method of work holding. This can take wide range of diameters. When adjusting jaws move equal amount light cuts should carry out, because the work may slip in the jaws. In addition, the work should be firmly round to fix in this chuck.

Fig.22Three Jaw Chuck

The independent centering chuck (4 – Jaw Chuck)
Each jaw is individually adjust and moves along its own slot. One advantage of this four-jaw chuck is that work can be located in the centre to run true or off centre. One of the most useful applications of this type is to hold square or rectangular material positioned either centrally or off centre. Setting time is greatly increased when compared to three-jaw chuck. However, for highly accurate work, this is the most suitable method.

Fig.23Four Jaw Chuck

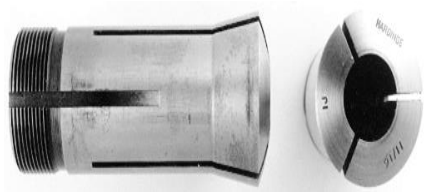


Fig.24Magnetic Chuck

Fig.25Collet Chuck

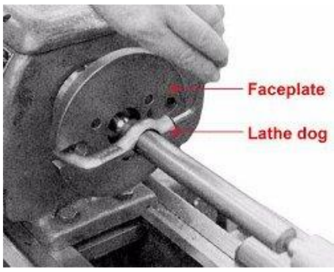


Fig.26Face Plate &Lathe Dog

Fig. 27Mandrels

Fig.28Follower rest

Fig.29Steady rest

Other Cutting Tool Holders are:

- Tool holders for the Lathe Carriage:
- Quick-change tool post, dovetail type
- Turning tool holder
- Threading tool holder
- Drill tool holder
- Boring tool holder
- Tailstock turret
- Quick change cutoff tool holder
- Quick change knurling and facing tool holder
- A four-tool turret tool holder (it can hold facing, turning, threading or boring tools)

Tool Holders for the Lathe Tailstock:

- Drill chuck
- Tailstock turret
- Standard-type tool post
- Straight shank tool holder
- Right hand tool holder for carbide tool bits
- Left hand tool holder
- Right hand tool holder
- Cutoff tool holders (R.H offset, straight, L.H offset)
- Boring bar tool post (light boring tool holder, heavy-duty boringbartool holder, medium boring tool holder)

DO's & DON'TSFOR THE LATHE

DO's

- ✓ Do Become Acquainted with the function of the important parts of lathe
- ✓ Do keep your machine properly lubricated
- ✓ Do keep machines clean and orderly. A dirty machine is not conducive to good workmanship.
- ✓ Do thoroughly understand & plan the job before starting to work on machine.
- ✓ Do keep the cutting tool sharp, dull cutting tools require a longer time to do the same job and give a poor finish and put the machine under an unwarranted strain.
- ✓ Do take as heavy a cut as a machine, work and cutting tool will permit. A series of light cuts wastes time and make necessary work for the operator.
- ✓ Do take interest in your work with responsibility.

DON'TS

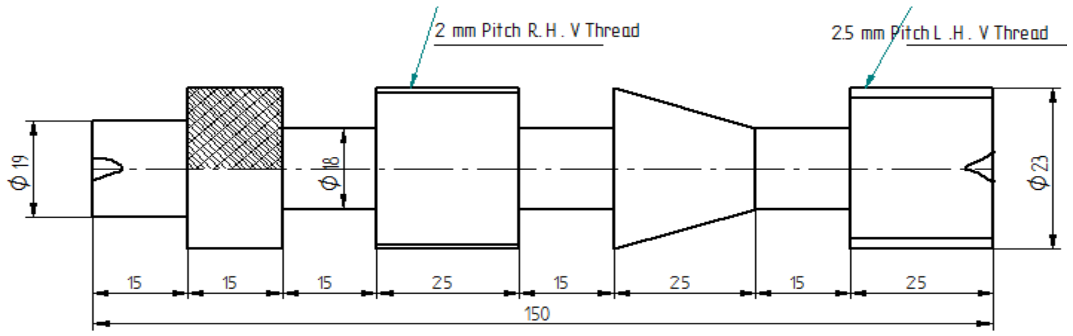
- ✗ Don't wear loose fitting shop coats or aprons when operating any machine.
- ✗ Don't ever leave the chuck wrench in the chuck.
- ✗ Don't push any lever or turn any handle on a lathe unless you know what will happen as a result.
- ✗ Don't wear long ties, finger rings while operating machine.
- ✗ Don't try to run a machine & engage in conversation at the same time. If you must talk then shut down the machine.
- ✗ Don't be afraid to wear goggles when turning work which produces flying chips.
- ✗ Don't attempt to check the hole when boring, without first covering the boring tool to guard against arm and hand injuries.
- ✗ Don't put your hand or fingers on any revolving work or toll at any time.
- ✗ Don't go away and leave your machine running. If you must leave then shut down.
- ✗ Don't drop chucks, face or drive plates or lay work or tools on the ways of the lathe
- ✗ Don't offer excuses when you scrap a job. Accept your responsibility and try to do better the next time.

Model – I

Turning Operations Performed on a Given Mild Steel Work Piece

Aim:

To perform various turning operations on the given Mild Steel Work piece as per the given drawing



ALL DIMENSIONS ARE IN MM

Tools Required:

Lathe Machine, Single Point Cutting Tool, Drill bit, Work piece, Vee Tool, Surface gauge, surface plate, V-Block, Centre Punch,

Tool kit (Chuck key, Tool post key, inside & outside Caliper, Steel Scale, Packing pieces& Brush)

Sequence of Operations:

1) Using the Outside Calipers the diameter of the given work piece is measured.
2) The facing operation is carried out on both sides of the work piece and a counter hole is drilled at the center.
3) The work piece is placed in the 3 jawchuck.
4) The tail stock is moved so that the work piece is held between the chuck and the dead center.
5) The tool aligned by placing such that, the tip of the tool is perpendicular to the tip of the dead center. The tool post is tightened using align key.
6) The tool is made to touch the work piece & the depth of the cut is adjusted to get the diameter of 23mm using a micrometer provided in compound rest or in the carriage.

7) Cutting parameters like speed, feed, depth of cut, etcare selected before the machine is turned on.
8) Plain turning operation is carried out for required length of 150mm.
9) Markings are made to perform step turning operation.
10) Step turning operations are made to get the desired shape of the work piece by giving depth of cut on each run.
11) Groove turning operations are made to get the desired shape of the work piece by giving depth of cut on each run
12) Taper turning angle is calculated using the taper angle formula and the compound rest is swiveled to the angle **"θ"** in degrees (as per the calculation) with the help of align key. The taper turning at this angleis performed for a length of 25 mm and depth of cut of 1 mm on each run.

$$\boldsymbol{\theta = \tan^{-1}\frac{(D-d)}{2l}}$$

Where	θ	=	Swivel the compound rest to the calculated angle.
	D	=	Major diameter.
	d	=	Minor diameter.
	l	=	Length of the taper.

13) Knurling operation is carried out by using special knurling tool.
14) To carry out thread cutting required pitch is noted down & depth of cut is calculated using formula. Using a standard chart the auto feed varying mechanism is set for 2mm pitch for the right hand thread cutting operation & 2.5mm pitch for left hand thread is carried out by engaging lead screw which rotates at required speed & direction for the mentioned thread along with suitable gears in gear train.
15) The procedure is repeated 13 times with an increment in depth of cut by 0.2 mm divisions each time. In case of right hand thread cutting operation feed will be from right to left.
16) The procedure is repeated 16 times with an increment in depth of cut by 0.2 mm divisions each time. In case of left hand thread cutting operation feed will be from left to right.
17) For 'V' – thread cutting, Angle of thread is 60^0, According to the ISO standard metric thread depth = 0.65X pitch (60 to 65%)
18) After turning with the help of pitch gauge check the accuracy of the thread pitch and with the help of Vernier caliper, check the diameter of turned part.

19) Finishing operation is done by giving very small depth of cut (say 0.2mm) on medium feed.

Result:

The required turning operations are carried out on the given work piece as per the figure given with the dimensional accuracy.

Observations &Calculations:

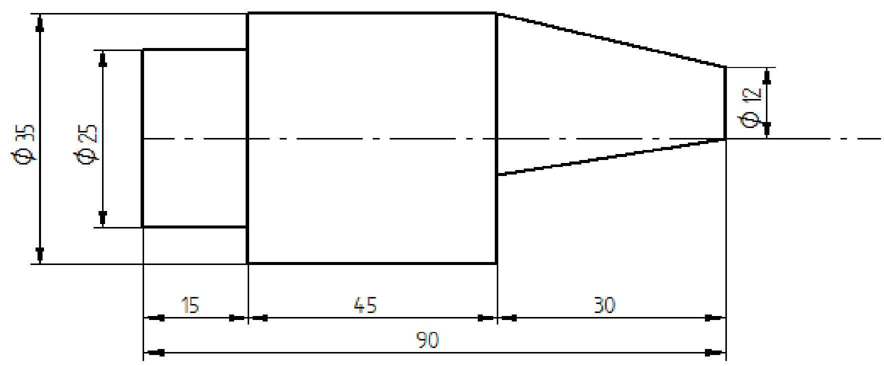
1.	Work piece material	:	………………………
2.	Cutting Tool Material	:	………………………
3.	Feed	:	………………………mm/revolution.
4.	Depth of Cut	:	………………………mm
5.	Selected Cutting Speed	:	………………………m/min.
6.	Plain Turning	:	………………………m/min
7.	Step Turning	:	………………………m/min
8.	Taper Turning	:	………………………m/min
9.	Thread Cutting	:	………………………m/min
10.	Profile Turning	:	………………………m/min
11.	Knurling operation	:	………………………m/min

Model – II

Eccentric Turning

Aim:

To perform various turning operations on the given Mild Steel Work piece as per the given drawing.



ALL DIMENSIONS ARE IN MM

Tools Required:

Lathe Machine, Single Point Cutting Tool, Work piece, Left hand single point cutting Tool, Surface gauge, surface plate, V-Block, Centre Punch, vernier height gauge

Tool kit (Chuck key, Tool post key, inside & outside Caliper, Steel Scale, Packing pieces & Brush)

Procedure:

1) Using the Outside Calipers the diameter of the given work piece is measured.

2. The work piece is placed in the 4 jaw chuck and centering operation is performed using the surface gauge. .

2) The facing operation is carried out on both sides of the work piece .

3) The tool is made to touch the work piece & the depth of the cut is adjusted using a micrometer provided in compound rest or in the carriage

4) Cutting parameters like speed, feed, depth of cut, etc are selected before the machine is turned on

5) Now the work piece is removed and required marking on circular face of the work piece is made with the help of marking device like V-block, vernier height gauge, scriber, surface plate, etc

6) Markings are made to perform Eccentric turning operation.

7) The marked line is punched with the help of center punch.

8) Fix the work piece to the 4 jaw chuck & centering operation is carried out such that center of the circular face is exactly coinciding with axis of the lathe..

9) Eccentric turning operations are made to get the desired shape of the work piece by giving depth of cut 1mm on each run

10) .Taper turning angle is calculated using the taper angle formula and the compound rest is swiveled to the angle “ **θ** ” in degrees (as per the calculation) with the help of align key. The taper turning at this angle is performed for a length of 30mm and depth of cut of 0.5mm on each run.

$$\boldsymbol{\theta = \tan^{-1}\frac{(D-d)}{2l}}$$

Where	θ	=	Swivel the compound rest to the calculated angle.
	D	=	Major diameter.
	d	=	Minor diameter.
	l	=	Length of the taper.

.

11.Step turning operations are made to get the desired shape of the work piece by giving depth of cut on each run.

Result:

The required turning operations are carried out on the given work piece as per the figure given with the dimensional accuracy.

Observations & Calculations:

1.	Work piece material	:	………………………
2.	Cutting Tool Material	:	………………………
3.	Feed	:	………………………mm/revolution.
4.	Depth of Cut	:	………………………mm
5.	Selected Cutting Speed	:	………………………m/min.
6.	Plain Turning	:	………………………m/min
7.	Step Turning	:	………………………m/min
8.	Taper Turning	:	………………………m/min
9.	Thread Cutting	:	………………………m/min
10.	Eccentric Turning	:	………………………m/min
11.	Knurling operation	:	………………………m/min

Dimensional Accuracy:

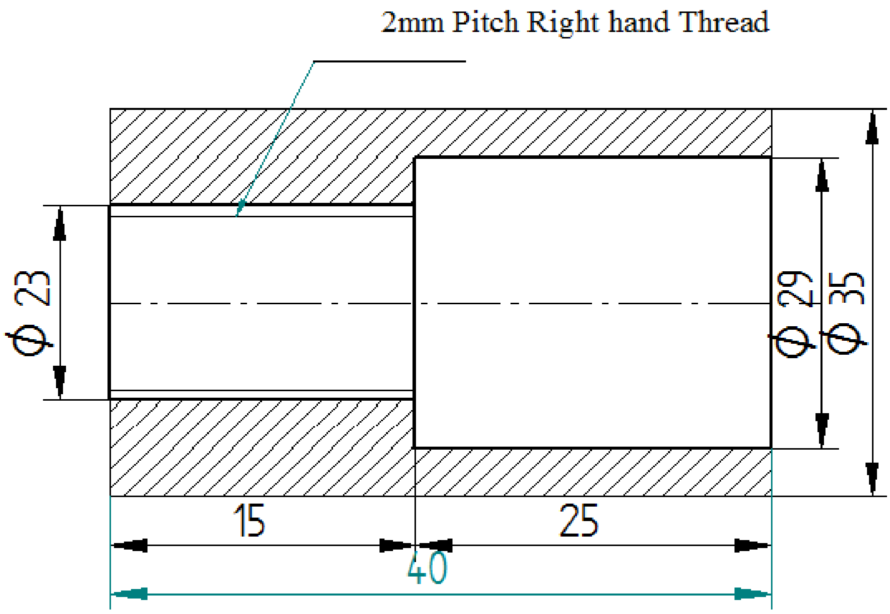
Diameter in mm	Given					
	Obtained					
Lengthin mm	Given					
	Obtained					

Model – III

Turning Operations Performed on a Given Mild Steel Work Piece

Aim:

To perform various turning operations on the given Mild Steel Work piece as per the given drawing



ALL DIMENSIONS ARE IN MM

Tools Required:

Lathe Machine, Single Point Cutting Tool, Drill bit, Work piece, Vee Tool, Surface gauge, surface plate, V-Block, Centre Punch,

Tool kit (Chuck key, Tool post key, inside & outside Caliper, Steel Scale, Packing pieces & Brush)

Sequence of Operations:

1) Using the Outside Calipers the diameter of the given work piece is measured.
2) The facing operation is carried out on both sides of the work piece and a counter hole is drilled at the center.
3) The work piece is placed in the 3 jaw chuck and centering operation is performed using the surface gauge.
4) The tool aligned by placing such that, the tip of the tool is perpendicular to the tip of the dead centre. The tool post is tightened using alin key.

5) Cutting parameters like speed, feed, depth of cut, etcare selected before the machine is turned on.

6) To carry out thread cutting required pitch is noted down & depth of cut is calculated as shown in the formula. Using a standard chart the auto feed varying mechanism is set for 2mm pitch & the right hand thread cutting operation is carried out by engaging lead screw which rotates at required speed & direction for the mentioned thread along with suitable gears in gear train.

7) The procedure is repeated 10 times with an increment in depth of cut by 2 divisions i.e. 0.1mm each time. In case of right hand thread cutting operation feed will be from right to left & vice versa for the left hand thread.

8) For 'V' – thread cutting, Angle of thread is 60^0, According to the ISO standard metric thread depth = 0.6 to 0.65 X pitch (60 to 65%)

9) Similarly for Square thread (flat side of the single point cutting tool is used), Depth = 0.5 to 0.55 X pitch (50 to 55%)

10) After turning with the help of pitch gauge check the accuracy of the thread pitch and with the help of vernier caliper, check the diameter of turned part.

11) Finishing operation is done by giving very small depth of cut (say 0.2mm) on medium feed.

12) ϕ8Drill Bit is fixed to the dead centre and advanced towards the work piece.

13) Drilling is carried out to a depth of 20mm on one circular face of the work piece.

14) Tapping operation is carried out on the other circular face of the work piece with the help of 3 tapping tools used as rough, medium and fine internal threading to a depth of 30mm.

15) Knurling operation is carried out by using special knurling tool.

Result:

The required turning operations are carried out on the given work piece as per the figure given with the dimensional accuracy.

Observations & Calculations:

1.	Work piece material	:	………………………
2.	Cutting Tool Material	:	………………………
3.	Feed	:	………………………mm/revolution.
4.	Depth of Cut	:	………………………mm
5.	Selected Cutting Speed	:	………………………m/min.

6. Plain Turning : ………………………m/min

7. Step Turning : ………………………m/min

8. Taper Turning : ………………………m/min

9. Thread Cutting : ………………………m/min

10. Eccentric Turning : ………………………m/min

11. Knurling operation : ………………………m/min

Dimensional Accuracy:

Diameter in mm	Given					
	Obtained					
Lengthin mm	Given					
	Obtained					

3. SHAPING MACHINE
(THE SHAPER)

3.1 Introduction:

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. The shaper is a relatively simple machine. It is used fairly often in the tool room or for machining one or two pieces for prototype work. Tooling is simple, and shapers do not always require operator attention while cutting. A shaping machine is used to machine flat surface. It can cut grooves, angles and many other shapes. The Main Function of shaper is to generate a flat surface by combination of linear movement of cutting tool and work piece.

Shaping is where the work piece is fed at right angles to the cutting motion between successive strokes of the tool. Shaping and planners among the oldest techniques used and Shapers are where the work piece is fed at right angles to the cutting motion between successive strokes of the tool. In Planners the work piece is reciprocated and the tool is fed at right angles to the cutting motion. These processes require skilled operators and for the most part have been replaced by other processes

The horizontal shaper is the most common type and its principal components are shown below and described as follows:

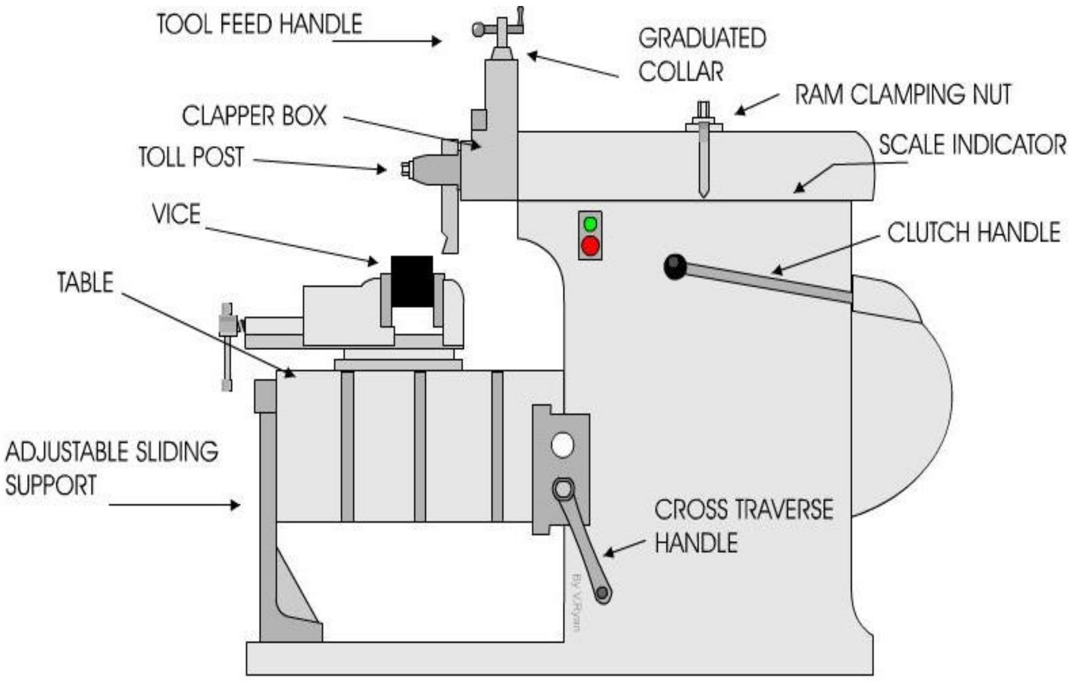


Fig.30 Horizontal Shaper Machine

3.2 Parts of Shaper:

Base:

It is a heavy and robust cast iron body. The base supports the column or pillar which supports all the working parts such as ram, work-table, drive mechanism etc.

Column or Pillar:

The column is a ribbed casting of cellular construction. The ram slide ways are provided on the top of the column while the table slide ways are machined on the front. The crank and slotted link mechanism that drives the ram is contained within the column. The driving motor, variable speed gear box, levers, handles and other controls of shaper are also contained in the column.

Ram:

Ram is a rigidly braced casting and is located on the top of the column. The ram slides back and forth in dovetail or square ways to transmit power to the cutter. The starting point and the length of the stroke can be adjusted using stroke positioning mechanism and the down feed mechanism.

Tool head:

It is the device which holds the tool. The tool head slides in a dovetail at the front of the ram by means of T-bolt sand is fastened to the ram on a circular plate so that it can be rotated for making angular cuts. It can swivel from 0° to 90° in a vertical plane. The tool head can be raised or lowered by hand feed for vertical cuts on the work piece by its hand crank for precise depth adjustments.

Clapper Box:

The clapper box is needed because the cutter drags over the work on the return stroke. The clapper box is hinged so that the cutting too] will not dig in. Often this clapper box is automatically raised by mechanical, air, or hydraulic action.

Cross Rail:

The Cross rail is a heavy casting attached to the column at its front on the vertical guide ways. It carries the horizontal table slide ways. The cross rail can be raised or lowered by means of an elevating screw in order to compensate for different thicknesses of work.

Table: It is made of cast iron and has box type construction. It holds and supports the work during the operation and slides along the cross rail to provide feed to the work. T-slots are provided on its top and sides for securing the work to it. The table is moved left and right, usually by hand, to position the work under the cutter when setting up. Then, either by hand or more often automatically, the table is moved sideways to feed the work under the cutter at the end or beginning of each stroke.

Saddle:

The saddle moves up and down (Y axis), usually manually, to set the rough position of the depth of cut. Final depth can be set by the hand crank on the tool head.

Tool holders:

Tool holders are the same as the ones used on at engine lathe, though often larger in size. The cutter is sharpenedwith rake and clearance angles similar to lathe tools though the angles are smaller because the work surface is usually flat. These cutters are fastened into the tool holder.

Work holding:

Work holding is frequently done in a vise. The vise is specially designed for use in shapers and has long ways which allow the jaws to open up to 14" or more, therefore quite large work pieces can be held. The vise may also have a swivel base so that cuts may be made at an angle. Work that cannot be held in the vise (due to size or shape) is clamped directly to the shaper table in much the same way as parts are secured on milling machine tables.

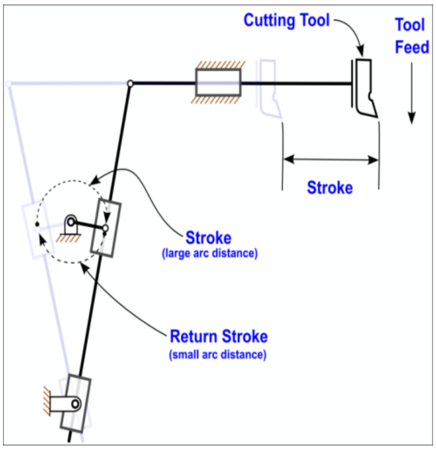
3.3 Classification of Shapers:

According to the reciprocating motion to the ram:

Crank type
Geared type
Hydraulic type

3.3.1 Quick Return Mechanism

This is the most common type of shaper in which a single point cutting tool is given a reciprocating equal to the length of the stroke desired while the work is clamped in position on an adjustable table. In construction, the crank shaper employs a crank mechanism to change circular motion of a large gear called "bull gear" incorporated in the machine to reciprocating motion of the ram. The bull gear receives power either from an individual motor or from an overhead line shaft if it is a belt driven shaper. The shaping machine is used to machine flat metal surfaces. The reciprocating motion of the mechanism inside the shaping machine can be seen in the diagram. As the disc rotates the top of the machine moves forwards and backwards, pushing a cutting tool. The cutting tool removes the metal from work which is carefully bolted down.



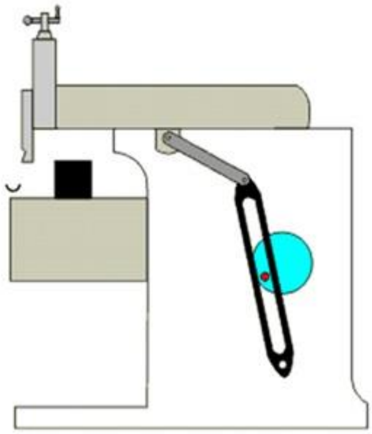


Fig.31 Quick return mechanism for shaper

3.3.2 Geared Type

The reciprocating motion of the ram in some type of shaper is affected by means of a rack and pinion. The rack teeth which are cut directly below the ram mesh with a spur gear. The pinion meshing with the rack is driven by a gear train. The speed and the direction in which the machine will traverse depend on the number of gears in the gear train. This type of shaper in not very widely used

Fig.32Gear Shaping Machine

3.3.3 Hydraulic Mechanism

In a hydraulic shaper, reciprocating movement of the ram is obtained by hydraulic power. Oil under high pressure is pumped into the operating cylinder fitted with a piston. The end of the piston red is connected to the ram. The high pressure oil first acts on one side of the piston and then on the other causing the piston to reciprocate and the motion ist5ransmitted to the ram. The piston speed is changed by varying the amount of liquid delivered by the pump. One of the most important advantages of this type of shaper is that the cutting speed and force of the ram drive are constant from the very beginning to the end of the cut. It also offers great flexibility of speed and feed control., eliminates shock and permits slip or slowing up of motion when the cutting tool is overloaded, protecting the parts or the tools from breakage. Another advantage is that the machine does not make any noise and operates very quietly.

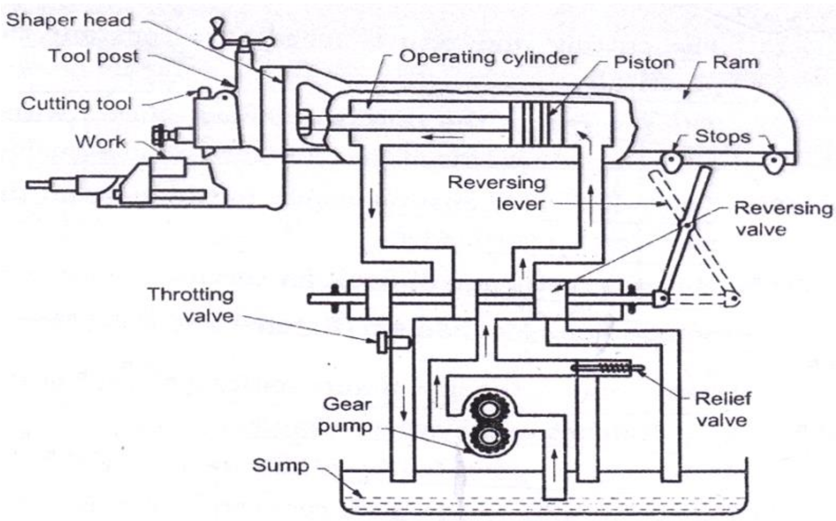


Fig.33 Hydraulic Drive for a shaper

3.4According to the position and travel of the ram:

Horizontal type
Vertical type
Travelling head type

3.4.1 Horizontal Shaper:

In a horizontal shaper, the ram holding the tool reciprocates in a horizontal axis.
Horizontal shapers are mainly used to produce flat surfaces.

3.4.2 Vertical Shaper:

In a vertical shaper, the ram holding the tool reciprocates in a vertical axis. In some of the vertical machines provision is made to allow adjustment of the ram to an angle of about10 degrees from the vertical position. Vertical shapers may be crank driven, rack driven, screw driven or hydraulic power driven. The work table of a vertical shaper can be given cross, longitudinal, and rotary movement. The tool used on a vertical shaper is entirely different from that used on a horizontal shaper. Vertical shapers are very convenient for machining internal surface, keyways, slots or groves. Large internal and external gears may also be machined by indexing arrangement of the rotary table. There are vertical shapers which are specially designed for machining internal keyways. They are then called key seaters.

3.4.3 Travelling Shaper:

In a traveling head shaper, the ram carrying the tool while it reciprocates movescrosswise to give the required feed. Heavy and unwieldy jobs which are very difficult to holdon the table of a standard fed past the tool are held static on the basement of the machinewhilethe reciprocates and supplies the feeding movements.

3.5According to the type of design to the table:

Standard shaper
Universal shaper

3.5.1 Standard shaper

A shaper is termed as standard or plain when the table has only two movements,vertical and horizontal, to give the feed. The table may or may not be supported at the outer end.

3.5.2 Universal Shaper:

In a universal shaper, in addition to the two movements provided on the table of astandard shaper, the table can be swiveled about an axis parallel to the ram ways, and upper portion of the table can be tilted about a second horizontal axis perpendicular to the first axis.As the work mounted on the table can be adjusted in different planes, the machine is mostsuitable for different types of work and is given name "Universal". A universal is mostlyused in tool room work.

3.6According to the type of cutting stroke:

Push type
Drew type

3.6.1 Push Type Shaper:

This is the most general type of shaper used in common practice. The metal is removed when the ram moves away from the column, i.e pushes the work.

3.6.2 Draw Type Shaper:

In a draw shaper, the metal is removed when the ram moves towards the column of themachine, i.e., draws the work towards the machine. The tool is set in a reversed direction tothat of a standard shaper. The ram is generally supported by an overhead arm which ensuresrigidity and eliminates deflection of the tool. In this shaper the cutting pressure acts towardsthe column which relieves the cross rail and other bearings from excessive lading and allowsstaking deep cuts. Vibration in these machines is practically eliminated.

3.7 Shaper Specifications:

Shaper machine are manufactured by taking account of the following specifications:

1. Length of Stroke
2. Maximum Horizontal Travel of Table
3. Maximum Vertical Travel of Table
4. Maximum distance from Table to Ram
5. Maximum Vertical Travel of Tool Slide
6. Length &Width of Table Top

7. Length &Depth of Table Side
8. Power of Motor

3.7 Operations on Shaper:

Machining Horizontal Surface:
Set the vice jaws length perpendicular to the ram movement. Hold the job length-wise parallel to the tool stroke so that maximum stroke of the tool may be utilized. Hold the appropriate tool in tool head. Set the proper inclination of the tool and depth of cut. Give cross feed to the tool initially by hand till the cut start and then employ power feed.
Repeat the above said procedure.

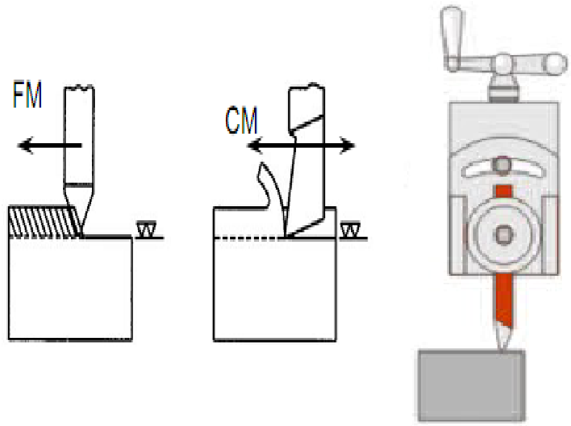


Fig.34 Horizontal Shaping

Machining Vertical Surface:
The tool is fed downward in vertical cutting so swivel the clapper box from the face of the work to be cut. The tool is fed downwards by rotating the down feed screw by hand at the end of return stroke. On the return stroke the tool swings away from the work and gives clearance, which prevents the work from being scratched. Start cutting from highest point towards the bottom.
Repeat the procedure for another cut.

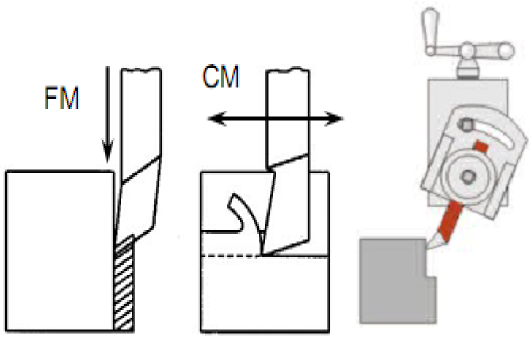


Fig.35Vertical Shaping

Machining Angular Surfaces:
Set the swivel head to the required angel for shaping angular faces. The clapper box is to be swung away from the face to be machined. The tool is to be fed by the slide hand wheel. The apron top is also swiveled in the direction away from the surface to be machined. Feed the tool during return stroke. Repeat the procedure to finish the work.

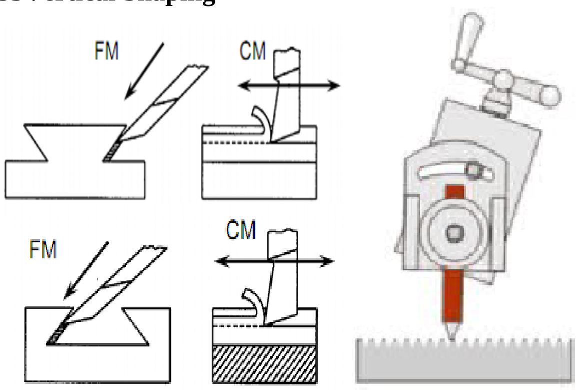


Fig.36 Angular Shaping

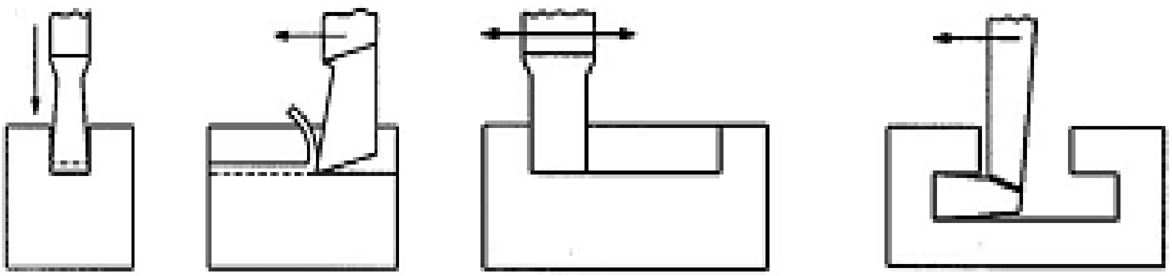


Fig.37Slotting operation **Fig.38 Pocketing operation** **Fig.39 T-Slot cutting**

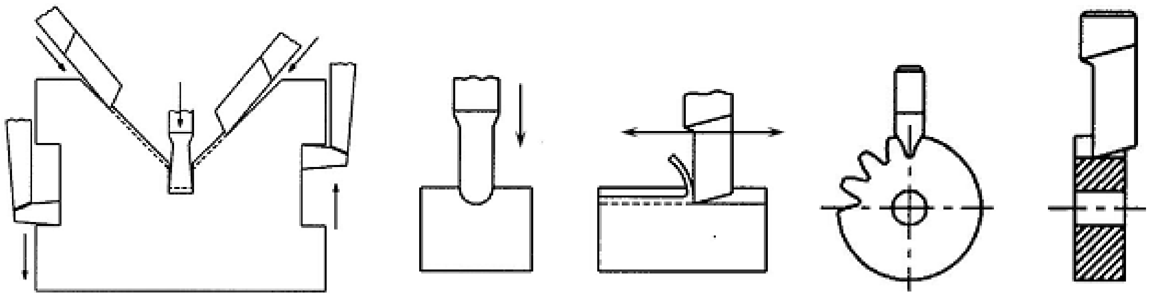


Fig.40Vee-block Cutting **Fig.41 Groove Cutting** **Fig. 42Spur Gear**

4 Some unusual work such as slotting operation, pocketing, T-Slot Cutting, Vee - Block Cutting, Grooving, Spur Gear cutting using straight tooth, etc, can also be done, if needed, by developing and using special attachments.

DO's & DON'TS FOR THE SHAPER

DO'S

- ✓ Do thoroughly understand the requirements of the job.
- ✓ Do see that there is at least 2" clearance between the ram and the vise or work.
- ✓ Do keep your hands away from the moving work & tool holder.
- ✓ Do make sure that the job is held securely.
- ✓ Do keep your mind on the work.
- ✓ Do make sure that the tool head is not down too far.
- ✓ Do see that the shaper is well oiled.

DON'TS

- ✗ Don't walk away from the shaper and leave machine running.
- ✗ Don't stand directly in front of shaper while it is in operation.
- ✗ Don't try to feed the tool head down without loosening the gib friction bolt.
- ✗ Don't forget to increase the speed of the ram before taking a finishing cut. It gives a better finish and completes the job in a shorter time.
- ✗ Don't hammer on the tool head or clapper box to swivel them. Loosen the nuts sufficiently so that the head pr box can be turned easily by the hand.

Model - IV

To perform Shaping Operations on a given Mild Steel Work Piece as per the figure given

Aim:

To produce a rectangular groove on a given casted rectangular blank with the help of shaping operations.

Tools Required:

Shaper machine, spirit level gauge, shaper tools, surface plate, vernier height gauge, scriber, vernier caliper

Sequence of operations:

1) Select suitable horizontal shaper.
2) Fix the given work piece on shaper table with the help of universal vice rigidly.
3) Set the cutting stroke and return stroke of the shaper, the length of the shaper should not exceed 3 times length of rectangular blank.
4) Select proper shaper tool and fix the tool on tool head of the shaper with minimum clearance of 5 to 6mm.
5) The exact position of the tool is perpendicular to the rectangular face of the work piece.
6) Switch on the shaper; feed the reciprocating tool against the rigidly fixed rectangular bank by table feeding mechanism.
7) Required depth of cut 1.5mm isgiven by rotating the tool head hand wheel with graduated micrometer.
8) Desired feed like 0.5mm/stroke is given to the work piece through the feeding mechanism incorporated for each cutting stroke up a length of 10mm.
9) Machine surface" A' de clamp and deburr corners.
10) Butt Finish the surface A against the fixed jaw so that A and B are perpendicular to each other.
11) Machine surface de clamp and deburr corners.
12) Check the squareness between surface A & B with tray square, if it is not square check the setting machine till squareness is obtained.
13) Butt surface B against the fixed jaw and rest surface A on the parallel and clamp.
14) Machine surface D to size and deburr .check the size and squareness.
15) Machine surface E to size and check the squarness
16) Machine surface F to size and check the squarnes.

17) Mark and punch as per drawing.

18) Shape the angular surface by swiveling the tool head at 45* without disturbing the job setting.

20) Shape the shaded portion as shown by swiveling the head at 45*in opposite direction.

21) Check the 45-degree angle with abevel protractor.

22) Set the Rectangulargroove to shape as shown in drawing.

23) Shape the rectangular groove (shaded) maintaining the dimensions.

24) Shape the shaded using manual feed without disturbing the job setting.

Result:

The required model is obtained and its dimensional accuracy is verified.

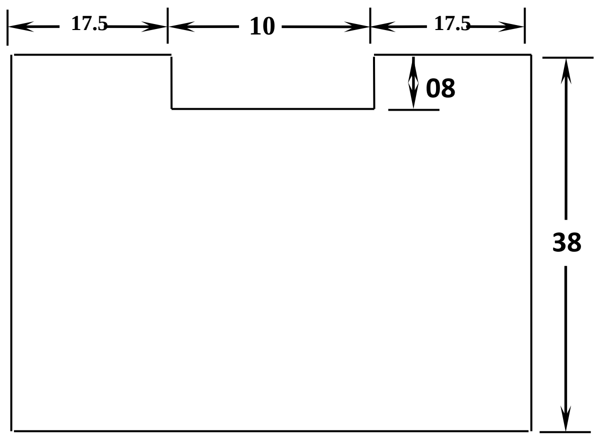


Fig. Rectangular Groove on work piece

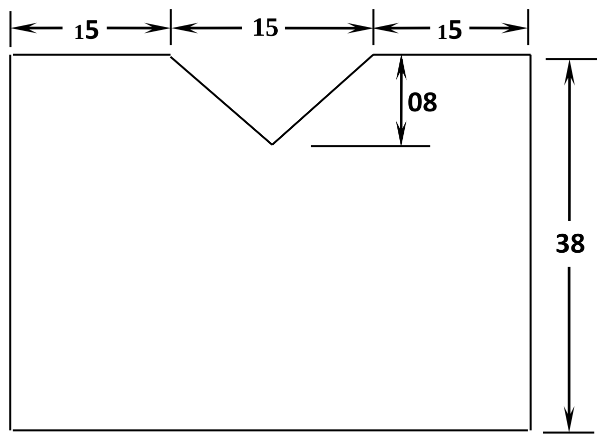


Fig. V-Groove on the work piece

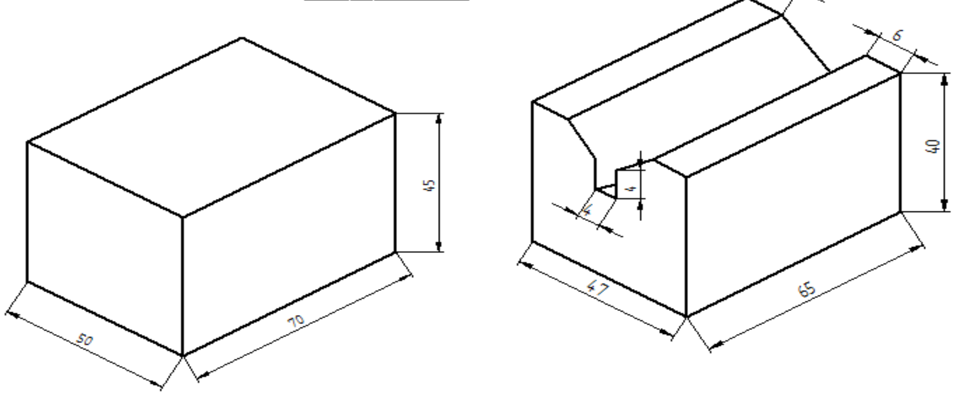
Observations & Calculations:

Work piece material : …………………….

Cutting tool material : …………………….

Shaper tool used : …………………….

V- BLOCK



ALL DIMENSIONS ARE IN MM

4.MILLING MACHINE

4.1 Introduction:

Milling machine is one of the most versatile conventional machine tools with a wide range of metal cutting capability. Many complicated operations such as indexing, gang milling, and straddle milling etc. can be carried out on a milling machine. Milling machines are among the most versatile and useful machine tools due to their capabilities to perform a variety of operations.

They can be broadly classified into the following types:

4.2 Column and Knee type milling machines:

Used for general purpose milling operations, column and knee type milling machines are the most common milling machines. The spindle to which the milling cutter is may be

HorizontalMilling Machine

Vertical Milling Machine.

Universal milling Machine

Bed type Milling Machines:

In bed type machines, the work table is mounted directly on the bed, which replaces the knee, and can move only longitudinally. These machines have high stiffness and are used for high production work.

Planer Milling Machines:

Planer machines are similar to bed type machines but are equipped with several cutters and heads to mill various surfaces.

Rotary Table Milling Machines:

Rotary table machines are similar to vertical milling machines and are equipped with one or more heads to do face milling operations.

Tracer Controlled Milling Machines:

Tracer controlled machines reproduce parts from a master model. They are used in the automotive and aerospace industries for machining complex parts and dies.

Computer Numerical Control (CNC) Milling Machines:

Various milling machine components are being replaced rapidly with computer numerical control (CNC) machines. These machine tools are versatile and are capable of milling, drilling, boring and tapping with repetitive accuracy.

Special Purpose Milling Machine:

Example: A five-axis profile milling machine having three principal linear movement and two angular movements of machine components

4.3 Horizontal Milling Machine:

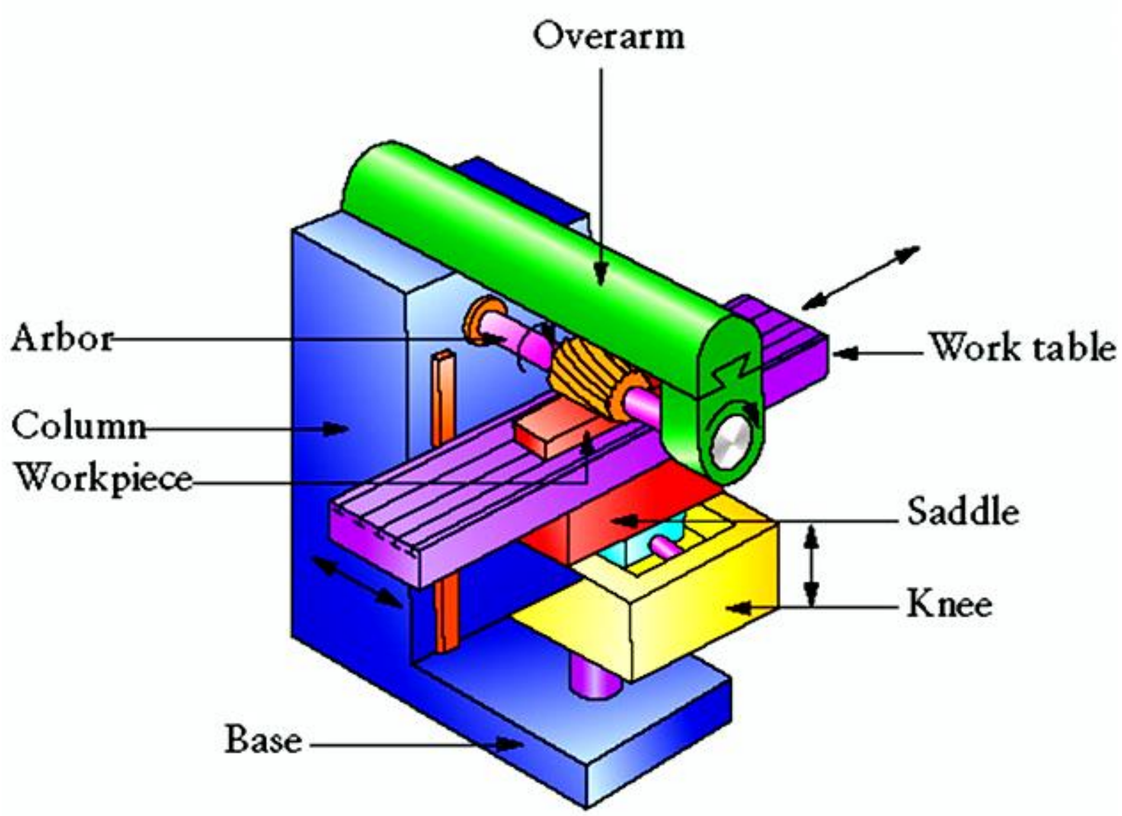


Fig.43 Horizontal Milling Machine

Parts

Column:

The column houses the spindle, the bearings, the gearbox, the clutches, the shafts, the pumps, and the shifting mechanisms for transmitting power from the electric motor to the spindle at a selected speed.

Knee:

The knee mounted in front of the column is for supporting the table and to provide an up or down motion along the Z axis.

Saddle:

The saddle consists of two slide ways, one on the top and one at the bottom located at 90º to each other, for providing motions in the X or Y axes by means of lead screws.

Table:

The table is mounted on top of the saddle and can be moved along the X axis. On top of the table are some T-slots for the mounting of workpiece or clamping fixtures.

Arbor:

The arbor is an extension of the spindle for mounting cutters. Usually, the thread end of an arbor is of left hand helix.

4.4 Vertical Milling Machine:

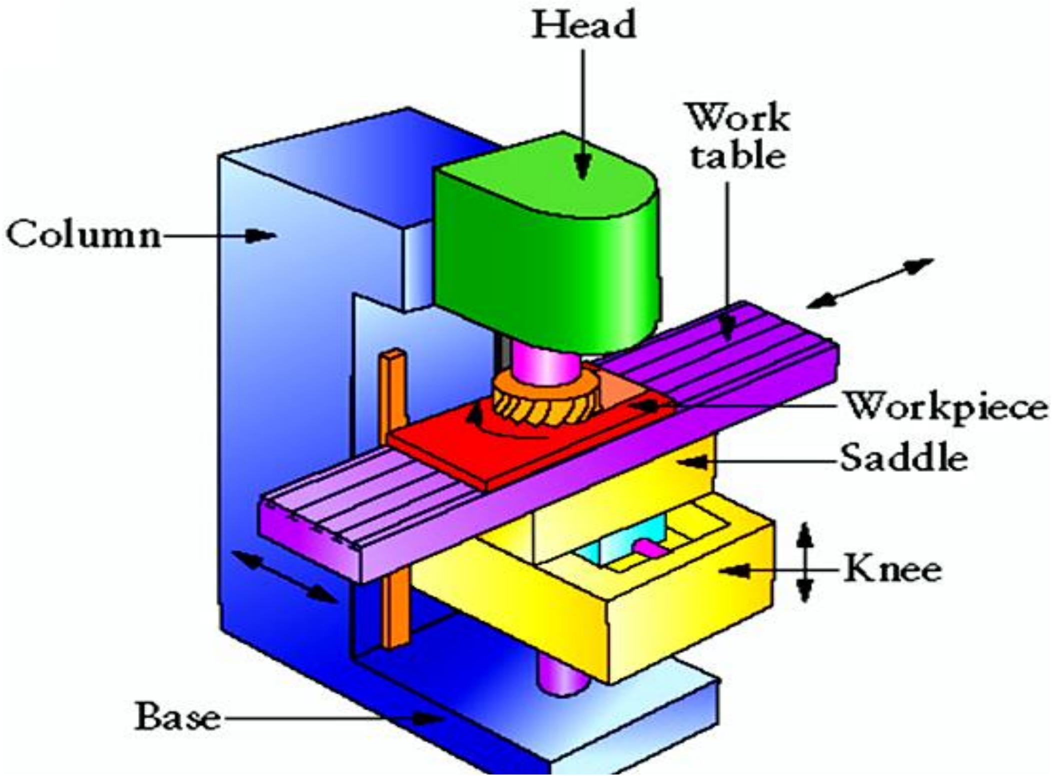


Fig.44VerticalMilling Machine

Column:

The column houses the spindle, the bearings, the gearbox, the clutches, the shafts, the pumps, and the shifting mechanisms for transmitting power from the electric motor to the spindle at a selected speed.

Knee:

The knee mounted in front of the column is for supporting the table and to provide an up or down motion along the Z axis.

Saddle:

The saddle consists of two slide ways, one on the top and one at the bottom located at 90^o to each other, for providing motions in the X or Y axes by means of lead screws.

Table:

The table is mounted on top of the saddle and can be moved along the X axis. On top of the table are some T-slots for the mounting of workpiece or clamping fixtures.

Milling head:

The milling head consisting the spindle, the motor, and the feed control unit is mounted on a swivel base such that it can be set at any angle to the table.

Ram:

The ram on which the milling head is attached can be positioned forward and backward along the slide ways on the top of the column.

4.5 Milling Methods:

4.5.1 Up Milling:

In up cut milling, the cutter rotates in a direction opposite to the table feed as illustrated in the following Figure. It is conventionally used in most milling operations because the backlash between the lead screw and the nut of the machine table can be eliminated.

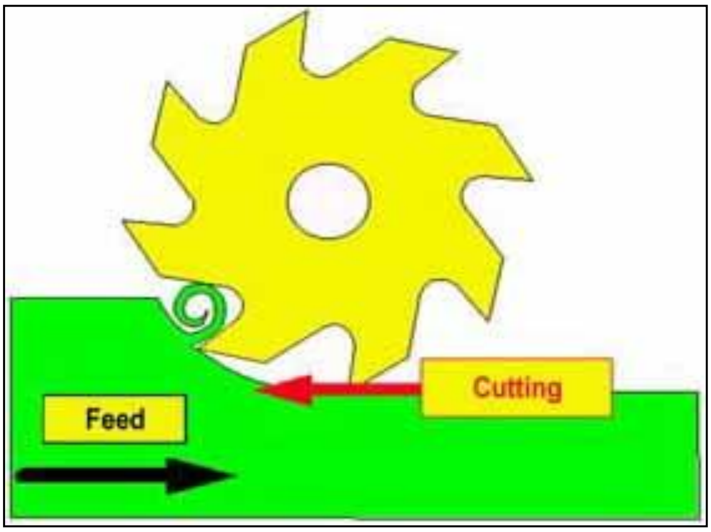


Fig.45Up Cut Milling

4.5.2 Down Milling:

In down cut milling, the cutter rotates in the same direction as the table feed as illustrated in the following Figure. This method is also known as Climb Milling and can only be used on machines equipped with a backlash eliminator or on a CNC milling machine. This method, when properly treated, will require less power in feeding the table and give a better surface finish on the workpiece.

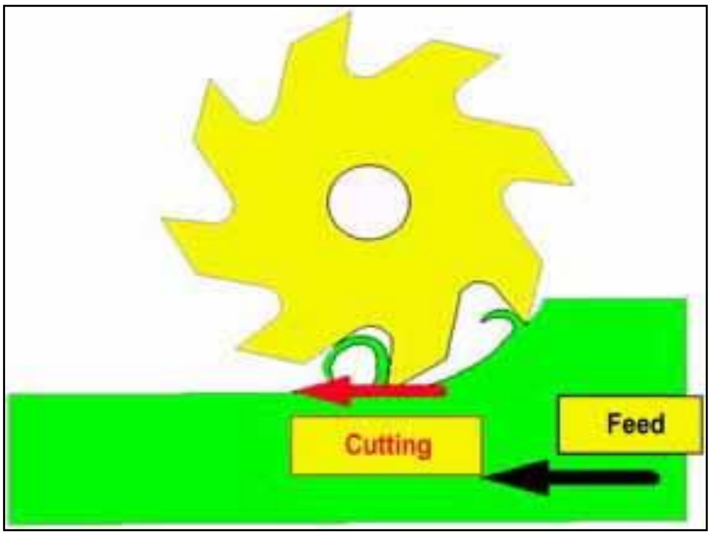


Fig.46Down Cut Milling

4.6 Milling Operations:

Milling operations are classified into two major categories

4.6.1 Peripheral Milling

Generally in a plane parallel to the axis of the cutter
Cross section of the milled surface corresponds to the contour of the cutter

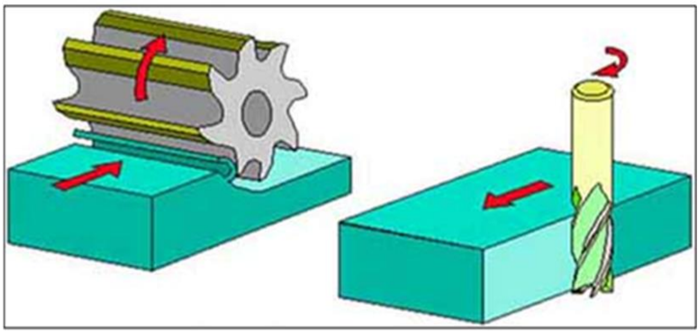


Fig.47 Peripheral Milling

4.6.2 Face Milling

Generally at right angles to the axis of rotation of the cutter
Milled surface is flat and has no relationship to the contour of the cutter
Combined cutting action of the side and face of the milling cutter

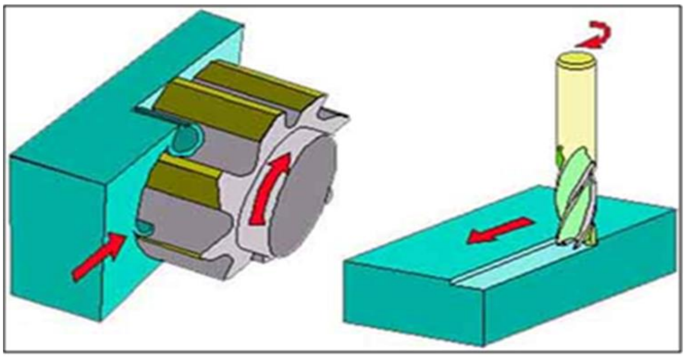


Fig.48 Face Milling

4.6.3 Slab milling:

A milling operation that uses a cylindrical mill on an axis parallel to the worktable to create a flat surface.

4.6.4 Slotting:

A milling operation that cuts a narrow ridge into the surface of a work piece.

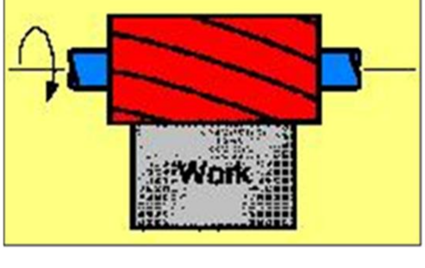


Fig.49 Slab Milling

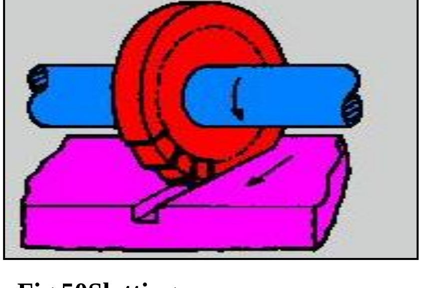


Fig.50Slotting

4.6.5 Slitting:

A rotary tool-steel cutting tool with peripheral teeth, used in a milling machine to remove material from the work piece through the relative motion of work piece and cutter.

4.6.6 Side milling:

Milling with a side-milling cutter to machine one vertical surface.

4.6.7 Form milling:

A milling operation that uses a mill with a unique shape to create that shape into the work piece.

4.6.8 Straddle milling:

Face milling of two parallel vertical surfaces of a work piece simultaneously by using two side-milling cutters.

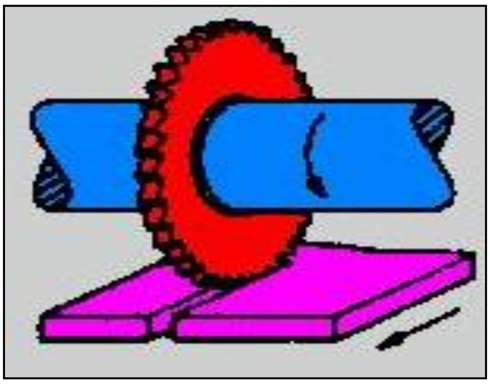


Fig.51 Slitting

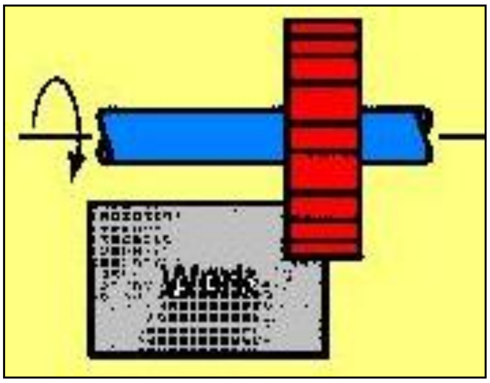


Fig.52 Side Milling

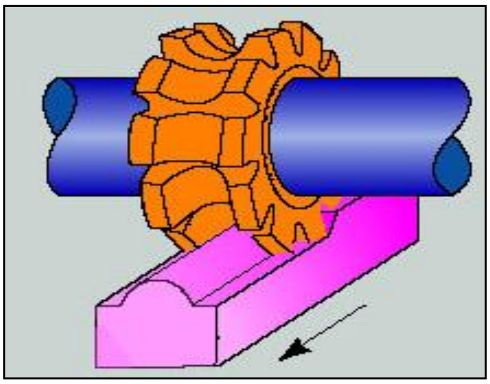


Fig.53 Form Milling

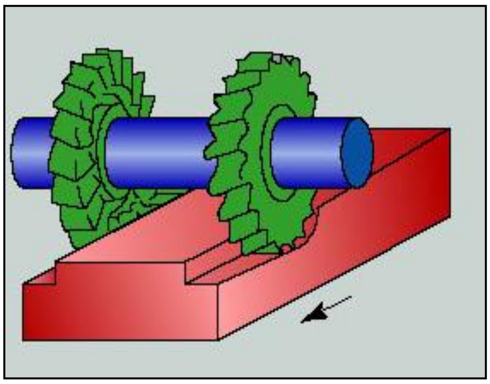


Fig.54 Straddle Milling

4.6.9 Face Milling

Conventional milling:
The diameter of the cutter is greater than the work part width, so that the cutter overhangs the work on both sides.

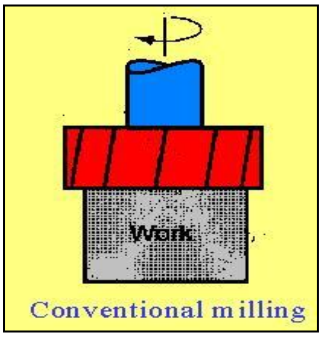
artial face milling:
The cutter overhangs the work on only one side.

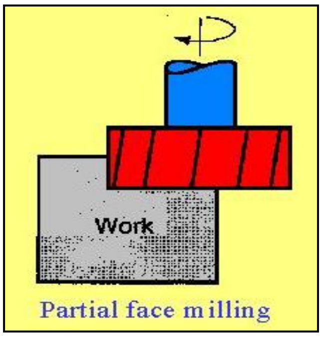
End milling:
The cutter diameter is less than the work width, so a slot is cut into the part.

Surface contouring:
A ball-nose cutter (rather than square end cutter) is fed back and forth across the work along a curvilinear path at close intervals to create a three-dimensional surface form.

Pocket milling:
Another form of end milling, this is used to mill shallow pockets into flat parts.

Profile milling:
This is form of end milling in which the outside periphery of a flat part is cut.





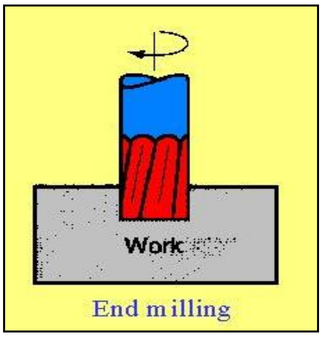
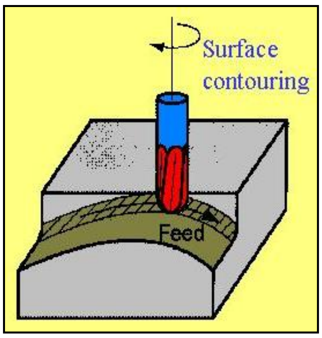
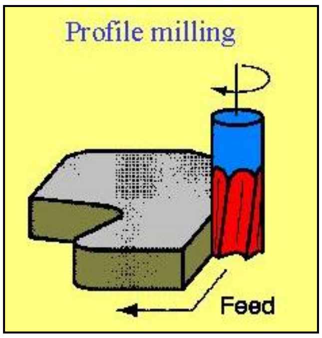


Fig.55 Conventional MillingFig.56 Partial Face Milling **Fig.57 End Milling**





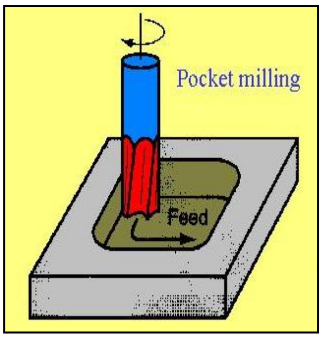


Fig.58 Surface Contouring **Fig.59 Pocket Milling** **Fig.60 Profile Milling**

4.7 Milling Cutter Types

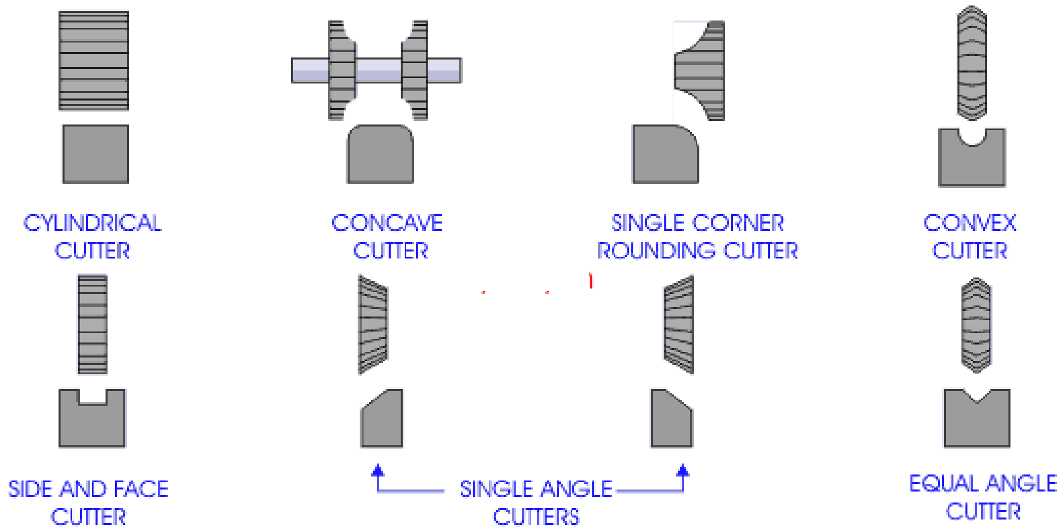


Fig.61 Various Milling Cutters

4.7.1 Cutting Tools for Horizontal Milling

Slab Mills:
For heavy cutting of large and flat surfaces.

Side and Face Cutters:
This type of cutters has cutting edges on the periphery and sides of the teeth for cutting shoulders and slots.

Slitting Saws:
For cutting deep slots or for parting off.

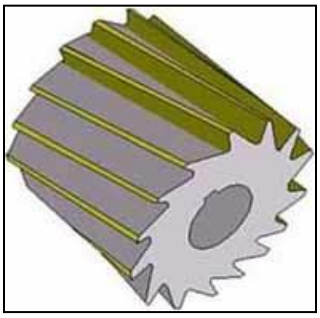


Fig.62 Slab Mill

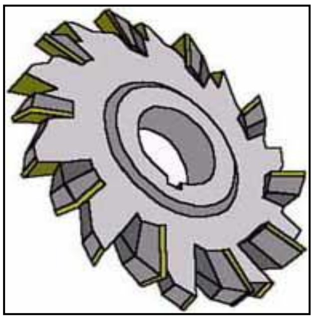


Fig.63 Side & Face Mill

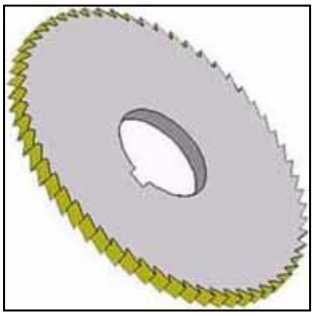


Fig.64 Slitting Saw

4.8 INDEXING:

It is defined as the method of dividing the circumference of the circular work piece into equally spaced divisions. Indexing head are of three types

Plain or Simple Indexing Head
Universal Dividing Head
Optically Dividing Head

4.8.1 Methods of Indexing:

Direct or Rapid Indexing
Simple or plain Indexing
Compound Indexing
Differential Indexing
Angular Indexing

Simple or Plain Indexing:

In this Indexing, the work piece is rotated by turning the crank as shown. When the crank is rotated the worm shaft rotates causing the worm to drive the worm wheel and consequently the spindle to turn. As spindle rotates, the work piece that is secured to spindle by means of a suitable holding device which also rotates

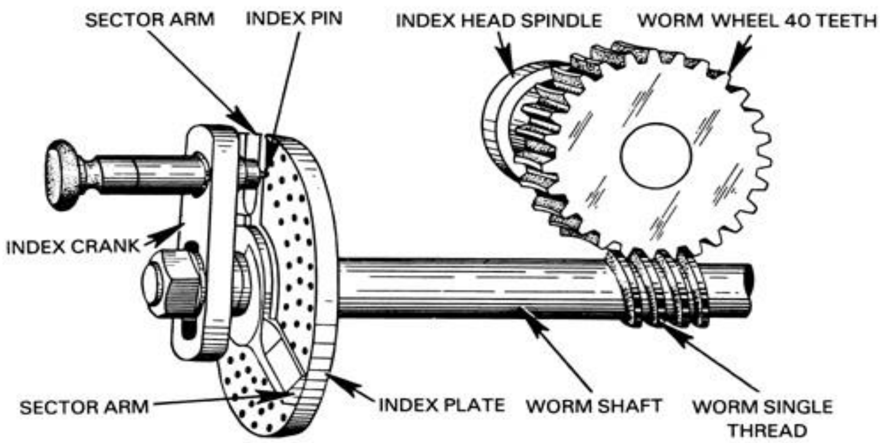


Fig.65 Simple Indexing Mechanism

Compound Indexing:

In this type of indexing is employed in those cases when the number of divisions required on the work piece cannot be obtained with the simple or plain index method.

This method involves two separate indexing movements that give the name compound indexing method.

This is performed in two stages:

1. The first movement is obtained by turning the work a definite amount in one direction in same way as in simple indexing.
2. The second index movement is obtained by turning the indexing plate along the crank.

Differential Indexing:

This is similar to compound indexing where the required division of the periphery of job is obtained by the combination of two movements

1) The movement of Indexing crank through the required number of spaces in one of whole circle of index plate as in case of simple indexing.

2) The simultaneous movement of index plate along with cranks either in same direction or reverses direction.

DO'S & DON'TS ON MILLING MACHINE

DO'S

- ✓ Do get thoroughly familiar with the stop lever.
- ✓ Do make sure that the work is held securely before engaging the cutter with it.
- ✓ Do make sure that all tools and machine parts are clear of the cutter before starting the machine.
- ✓ Do keep all cutters carefully to guard against any injury to yourself or others.
- ✓ Do keep the shirt sleeves rolled up above the elbows and wear close fitting shop aprons and coats.

DON'TS

- ✗ Don't under any circumstances attempt to operate any machine unless you are thoroughly familiar with it.
- ✗ Don't attempt to remove chips from the machine with your bare hand or fingers. Use brush or other suitable implement.
- ✗ Don't go away leaving machine running. If not then shutdown the machine.
- ✗ Don't attempt to oil the machines while it is in operation.
- ✗ Don't wear rings or long neckties while on the job.

Model - V

To perform gear cutting operation on milling machine

Aim:

To cut a spur gear teeth on a given circular blank by gear cutting processes.

Tools required:

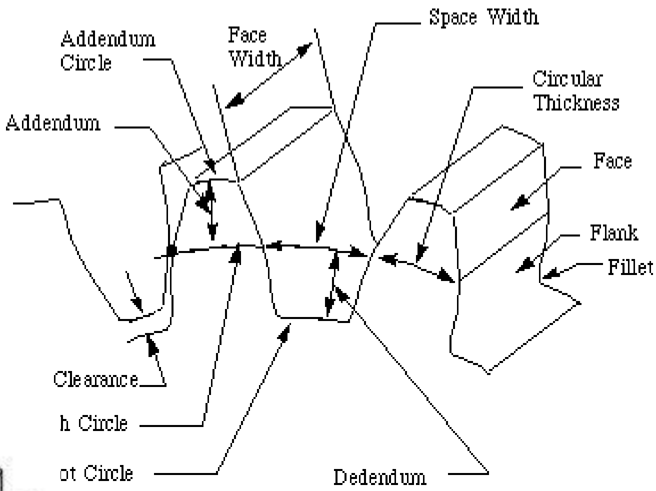
Horizontal milling machine, Spur gear cutter, vernier caliper, gear tooth vernier, indexing attachment.

Sequence of Operations:

1) Gear blank obtained by turning casted circular rod to desired dimensions with help of lathe.
2) A hole of 15mm is drilled exactly at the face center of the turning bar to the desired depth.
3) The blank of 25 mm width and 81mm external diameter and 15mm is parting off form the bar.
4) Select suitable cutter for spur gearing of module 2mm.
5) The gear blank is fixed in between dead center and dividing head center of the milling machine table.
6) Select suitable index plate and fix properly in the dividing head.
7) Raise the milling machine table by elevating screw, it will approach the cutter and check the alignment of the gear blank and the cutter and check the table moment limits for both transverse and cross feed.
8) Select the cutting speed of m/mm shifting, shifting speed lever and feed lever of the milling machine in milling head.
9) Switch on the machine, check for direction of cutter with respect to work piece.
10) Feed the gear blank against the rotating cutter by manual feeding of table by giving depth of cut in twice or thrice.
11) After completion of each tooth of gear, gear blank is moved away from the cutter.
12) Form dividing head suitable method of indexing is adopted to get the equal number is visions or made on gear blank according to indexing calculations.
13) Now move the sector arm of the dividing head to the next point and rotate the crank of dividing head to the desired number of rotation and move the crank pin on desired number of holes of the index plate to exact number of equal division on the gear blank.
14) Again the gear blank is fed on the rotating cutter and second teeth are completed by following step number 9.
15) Supply suitable cutting fluids at the time of machining and wear safety devises while machining is going on.

Result:

The desired spur gear is obtained by gear cutting operation and dimensional accuracy



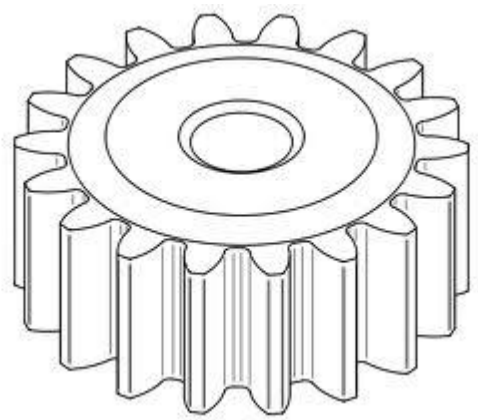


Fig: Spur Gear Description

Observations & Calculation:

No. of Teeth cut on gear blank is (N)……..ex: 30

Blank diameter = (Z +2) M

Where Z = no. of teeth

Simple indexing

No. of turns of index crank= $\frac{40}{N} = \frac{40}{30} = 1\frac{1}{3}$

Multiply by 9

$$1\frac{1}{3} X \frac{9}{9} = 1 \frac{9}{27}$$

i.e. each time, after cutting one teeth, the crank is given one complete rotation and crank pin can be moved by 9 holes on 27^{th} hole circle of index plate.

Depth of cut = 2.25 X M   M = Module = 2mm

Tooth depth = 2.25 X 2 = 4.5mm

Machine shop viva questions:

01. What do you mean by lathe?
02. What are all the various operations can be performed on a lathe?
03. What are all the principle parts of the lathe?
04. Difference between three jaw chuck and four jaw chuck
05. State the various parts mounted on the carriage?
06. write four types of tool post
07. What is an apron?
08. State any two specification of lathe?
09. List any four types of lathe?
10. What do you mean by semi-automatic lathe?
11. State the various feed mechanisms used for obtaining automatic feed?
12. List any four holding devices?
13. What are the different operations performed on the lathe?
14. State any two specifications of capstan lathe & turret lathe?
15. Compare the advantage of capstan lathe & turret lathe?
16. Define tooling?
17. What are the three stage of a tool-layout?
18. What are the different drives used in copying lathe?
19. What are the components that can be turned on a copying lathe?
20. Define automatic lathes.
21. Name the methods for driving machine tools in a machine shop
22. Differentiate between orthogonal and oblique cutting.
23. Why cutting forces are measured?
24. What are the different ways to measure the cutting forces?
25. List the various types of chips produced during metal cutting.
26. Why discontinuous chips are preferred over continuous chips?
27. List various types of chip breakers. Why they are used?
28. How do you define cutting speed and feed?
29. What are the factors that may be considered to fix cutting speed and feed?
30. Why heat is generated during cutting?
31. Why tools fail during cutting?
32. Give reasons for tool failure?
33. What are the factors that affect tool life?
34. How tool life can be measured?
35. What is machinability and machinability index?
36. What are the desirable characteristics of cutting tool materials?
37. Name various cutting tools?
38. Name various types of high speed steels?
39. What are the purposes of cutting fluids?
40. What are the different types of cutting tools?
41. Discuss the role of the tungsten, chromium and vanadium in HSS tool.
42. What is the main function of a lathe? List various types of lathes.
43. State the operations which may be performed on a lathe.

44. Why engine lathe is also called as centre lathe?
45. How a lathe is specified?
46. What are the basic parts of an engine lathe?
47. Why chucks are used? List various types of chucks used in lathes.
48. Distinguish rough and finish turning?
49. Define taper? How is the amount of taper expressed? Name different methods of taper turning done on a centre lathe?
50. What are the influences of cutting tool angles on machining?
51. Differentiate between a capstan, a turret and an engine lathe.
52. What are the differences between a capstan and a turret lathe?
53. Name different types of drilling machine tools?
54. How the size of a drilling machine is specified?
55. Name various work holding devices of drilling machine?
56. List various drilling machine operations.
57. How the drill size for tapping is fixed?
58. What is a spade drill? When it is used?
59. What is trepanning?
60. Difference between counter boring and counter sinking operation?
61. List various types of drill bits.
62. Name drill bit materials? Which material is mostly used?
63. What is a reamer? When it is used? List various types of reamers.
64. What is a tap? How taps are classified?
65. How tap nomenclature is described?
66. Classify and list shapers?
67. What are the advantages of hydraulic shaper over crank shaper?
68. What are the parts of a shaper?
69. How the size of the shaper is specified?
70. Describe the principle of quick return motion mechanism.
71. How you can adjust the length of stroke in a shaper?
72. Which way a shaper tool differs from lathe tool?
73. Define speed, feed and depth of cut in a shaper?
74. What is the fundamental difference between a planar and shaper?
75. List different types of planar.
76. How the size of a planar is specified?
77. List the main parts of a planar.
78. List various mechanisms for table drive in shaper.
79. What are feed mechanisms in a shaper?
80. List various work holding devices in a planar.
81. What types of operations can be performed efficiently on a planar?
82. List at least five differences between a planar and shaper.
83. Outline various grinding processes.
84. List various grinding processes.
85. What is the function of a grinding machine tool?
86. What is meant by universal grinder? How does it differ from a plain grinder?

87. What is centre less grinding? What are the advantages of grinding?
88. What are the different types of surface grinders?
89. How the size of a grinder is specified?
90. List various grinding operations.
91. Distinguish between wet grinding and dry grinding.
92. What nature and characters the abrasives used in grinding wheels have?
93. What is the function of bonds in grinding wheel? What are the bonding materials?
94. How a grinding wheel is marked (coded)?
95. How a grinding wheel is selected? List various factors that influence its selection.
96. What is the reason for balancing grinding wheel?
97. Classify milling machine. How milling differs from turning in lathe?
98. Name the three different table feeds?
99. What are the principle parts of a milling machine?
100. How the size of a milling machine is specified?
101. Name various work holding and cutter holding devices in milling.
102. Classify milling cutters. State the materials of the cutters used in milling.
103. What are the general characteristics of an end mill?
104. What are the reasons that you cannot use end mill as a drill?
105. What are the differences between single angle and double angle milling cutter?
106. List various milling operations.
107. Why surface finishing is an important manufacturing process?
108. Explain the process of lapping.
109. What is honing? How and why it is performed?
110. What is super finishing?
111. What is buffing, electroplating and polishing?
112. How nontraditional machining processes are classified?
113. List the differences between traditional and nontraditional machining processes.
114. List the common materials used in USM process.
115. List the common abrasives used in USM process.
116. What is the principle metal removal mechanism in USM process?
117. What is chemical machining process?
118. What are the common materials used for making tools in ECM process?
119. State the principle of ECM process.
120. What is plasma?
121. State the metal removal mechanism in thermal process.
122. What is used in LBM and EBM to remove the material from the w/p?
123. State the working principle of milling machine.
124. Differentiate between up milling and down milling?
125. What is indexing in milling? What are the different types of indexing used in milling?
126. State the working of drilling machine.
127. State the working of lathe machine
128. What are the different types of cutting fluids used in machine tools?
129. Define ultrasonic?
130. What do you meant by ultra high pressure (UHP)?