B.G.S
INSTITUTE OF TECHNOLOGY

MACHINE SHOP LAB

3rd SEMESTER

Sub code:17MEL38B

DEPARTMENT OF MECHANICAL ENGG

BGSIT, BG NAGARA

Department of Mechanical Engineering

LAB MANUAL

(2017–2018)

17MEL38B MACHINE SHOP LABORATORY

III Semester, Mechanical Engineering

Name : ______________________________

U S N : ______________________________

Batch : __________________ **Section :** __________

Department of Mechanical Engineering

Machine Shop

DEPARTMENT OF MECHANICAL ENGG.

MACHINE SHOP
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]
SEMESTER – III/IV

Subject Code: 15MEL38B/48B	IA Marks: 20
Number of Lecture Hrs / Week: 01	Exam Marks: 80
No of Practical Hours / Week: 02	Exam Hours: 03

CREDITS – 02

COURSE OBJECTIVES
- To provide an insight to different machine tools, accessories and attachments
- To train students into machining operations to enrich their practical skills
- To inculcate team qualities and expose students to shop floor activities
- To educate students about ethical, environmental and safety standards

COURSE OUTCOMES
At the end of the course, the students will be able to

COs	Description	CL	POs
CO1	Perform turning , facing , knurling , thread cutting, tapering , eccentric, turning and allied operations	A	PO1, PO6, PO9
CO2	Perform keyways / slots , grooves etc using shaper	A	PO1, PO6, PO9
CO3	Perform gear tooth cutting using milling machine	A	PO1, PO6, PO9
CO4	Understand the formation of cutting tool parameters of single point cutting tool using bench grinder / tool and cutter grinder	U	PO1, PO6
CO5	Understand Surface Milling/Slot Milling	U	PO1, PO6
CO6	Demonstrate precautions and safety norms followed in Machine Shop	U	PO8
CO7	Exhibit interpersonal skills towards working in a team	U	PO9

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

PART –C
For demonstration
Demonstration of formation of cutting parameters of single point cutting tool using bench grinder / tool & cutter grinder. Demonstration of surface milling /slot milling

One Model from Part – A	40 Marks
One Model from Part – B	20 Marks
Viva – Voce	20 Marks
Total	80 Marks

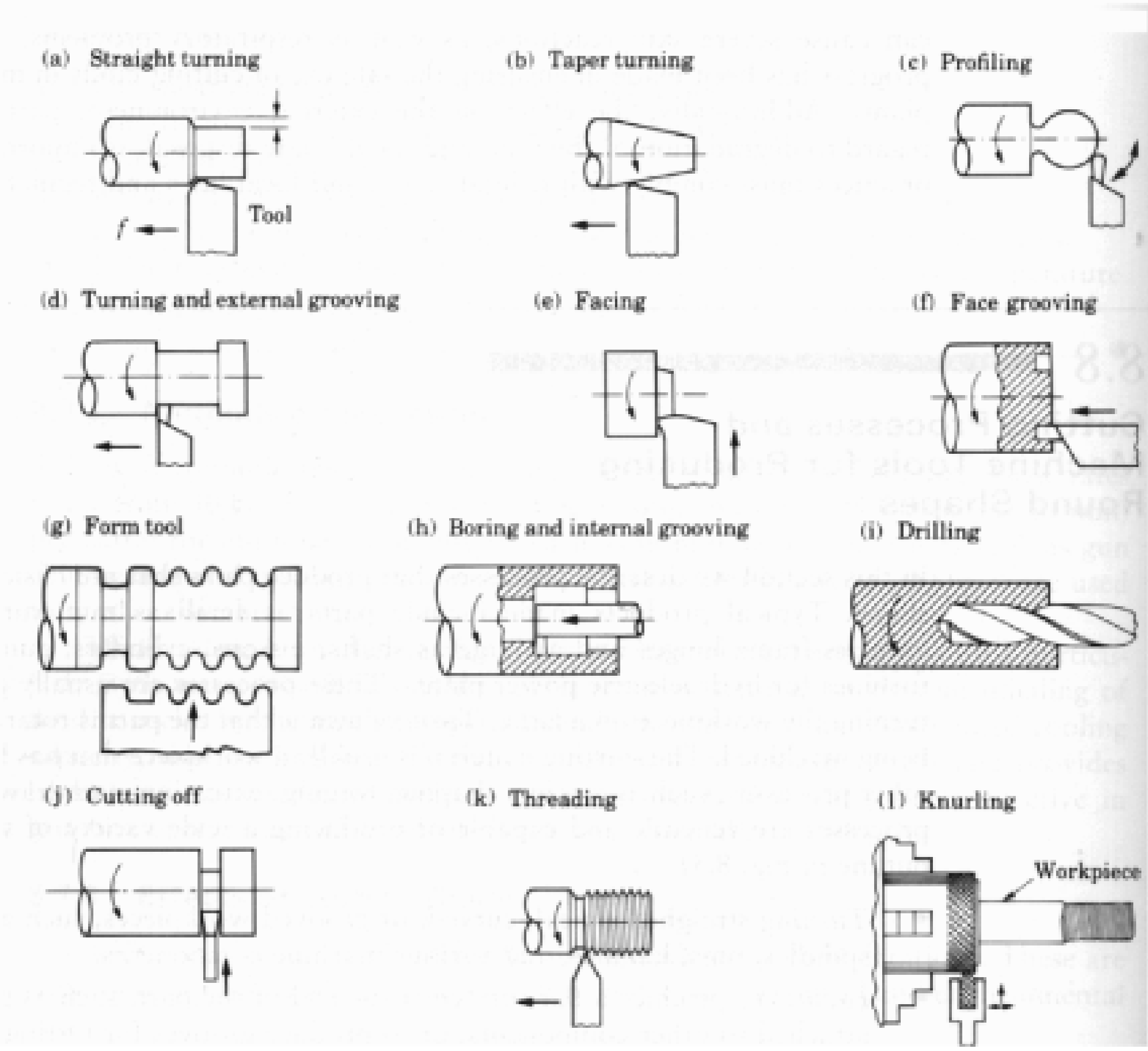
SAFETY MEASURES

- Do not attempt to operate the machine before receiving the instructions from the foreman.
- Never leave safe guards of lathe machine.
- Do not attempt to lift heavy article (more than 20 kg.) without assistance.
- Before starting any operation, always see the work and cutting tools secured first.
- Dis engages all the operating levers and place them in neutral position before starting the motor.
- Never leave the machine when it is running.
- Never mount or remove the work when machine is in running position.
- While machining such metal, which produces fine flying chip always wear goggle or use guard screen.
- Never wear loose clothing. Tie your sleeves up at wrist. Never handle chips or shavings with you bare hands; you should use special hook brushes or scrubbers to pull them away from the machine.
- Do not take measurement of the works while the machine is running.
- Do not tray to shop the chuck with your hands.
- Keep the work place clean and tidy. Never allow the work pieces or other objects to line on the floor around the machine.
- During mounting the work piece on the lathe be sure to see the Centre hole are correct. (in sufficient depth of center hole is likely to result in the work breaking away while it is revolving).
- See that the chuck key is removed after the work has been clamped in the chuck.
- The machine should be always earthed, if electric motor, lightning appliances or the wires insulation get out of order report it to the foreman or electrician on duty.

THE LATHE

The main function of a lathe is to remove metal from a piece of work to give it the required shape and size by holding the work securely and rigidly on the machine and then turning it against cutting tool which will remove metal from the work in the form of chips. The most common and widely used is the center or engine lathe for preparing of various turning parts by different turning process.

LATHE OPERATIONS



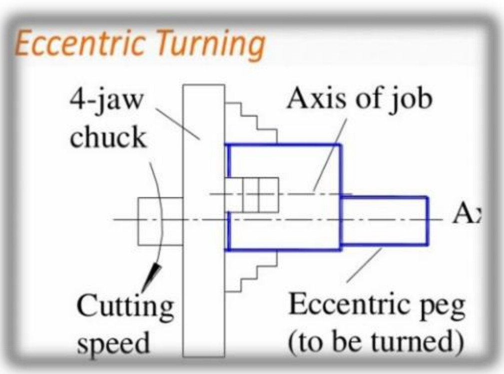
1. **Centering:** centering is the operation of producing conical holes in work pieces at the ends to provide bearing surface for lathe centers.

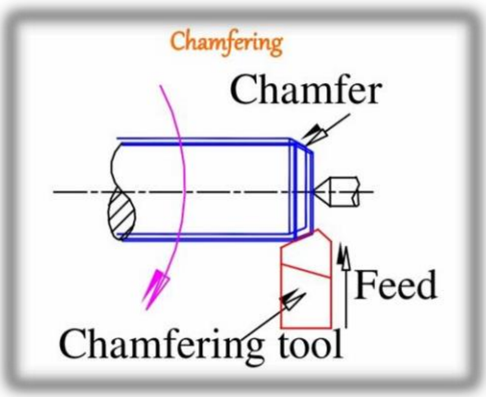
2. **Turning:** Turning is the process to remove excess material from the work piece basically to produce cylindrical or cone shaped objects, to the required shape and size. The most common center or engine lathe is used for preparing of various turning parts by different turning process. **Straight turning** produces a cylindrical surface by feeding the single point cutting tool against the rotating work parallel to the work.
3. **Taper turning:** means to produce a conical surface by gradual reduction in diameter from a cylindrical work piece.

4. **Facing:** Facing is the operation of machining the ends of a work piece to produce flat surface square with the axis. This is also used to cut the work to the required length. The tool is fed perpendicular to the axis of rotation of the work piece.

5. **Knurling:** Knurling is the process of embossing a diamond shaped pattern on the surface of the work piece. It provides grip to the work piece.

6. **Eccentric turning:** If the cylindrical work piece has two separate axis of rotation, one being out of the centre to the other, the work piece is eccentric and turning of different surfaces of the work piece is known as eccentric turning.





7. **Thread cutting:** The principle of thread cutting is to produce helical groove on a cylindrical or conical surface by feeding the tool longitudinally when the job is revolving between centers or by a chuck.

8. **Chamfering:** is the operation of beveling the extreme end of the work piece.

9. **Grooving:** is the process of reducing the diameter of a work piece over a very narrow surface.

10. **Undercutting:** is similar to grooving operation performed inside a hole called undercut.

The work pieces are given cylindrical shapes by:

1. Longitudinal turning
2. Tapers by taper turning
3. Profiles by profile turning
4. Threads by thread cutting

In addition, counter sink, drilling, reaming, grooving, knurling, parting off (operations) are carried out. Grinding and milling operations are carried out on the lathe with special attachments. The lathe is also used for manufacturing of cylindrical bolts, cylindrical shafts, shafts with square cross section, Eccentric shafts, crank shafts, bushes, sleeves, pulleys, knobs, machine handles, spindles, washers and machining of housing and casting etc.

Speed :

Speed is the number of circular motion of the spindle/work piece in one minute of time expressed is RPM.

Feed :

Feed is the length at which the tool travels forward for one revolution of the work piece expressed in meter/rev or mm/revolution.

Cutting speed:

The cutting speed of a tool is the speed at which the metal is removed by the tool from the work piece. It is the rate of cutting length on the main motion in meter/minute. It is denoted by a letter, v; $v = \pi dn/100$

Where

v = cutting speed.

d = diameter of the work piece.

n = number of revolutions per minute.

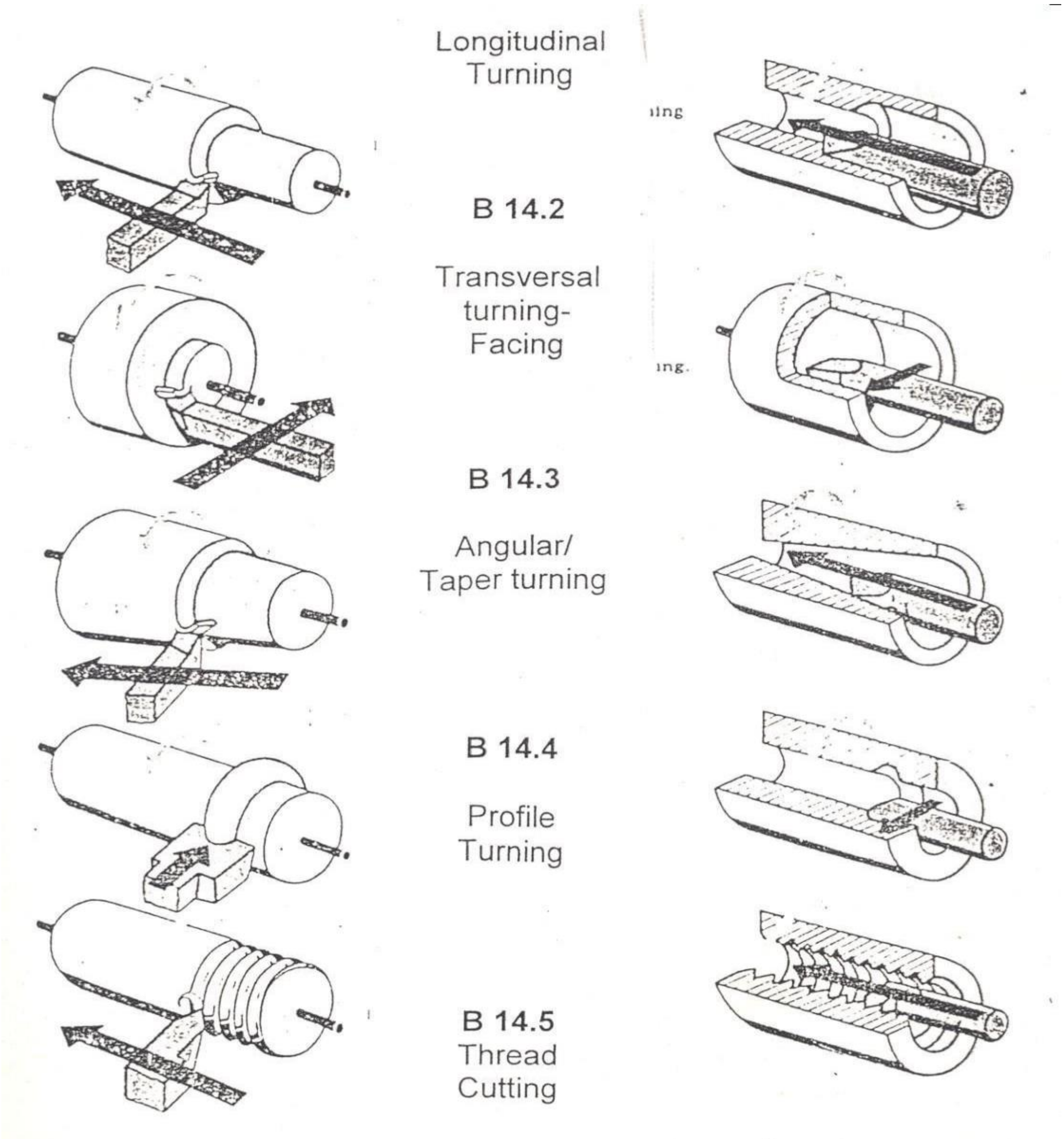
Depth of cut:

It is the perpendicular distance measured from the machined surface to the uncut surface of the work piece.

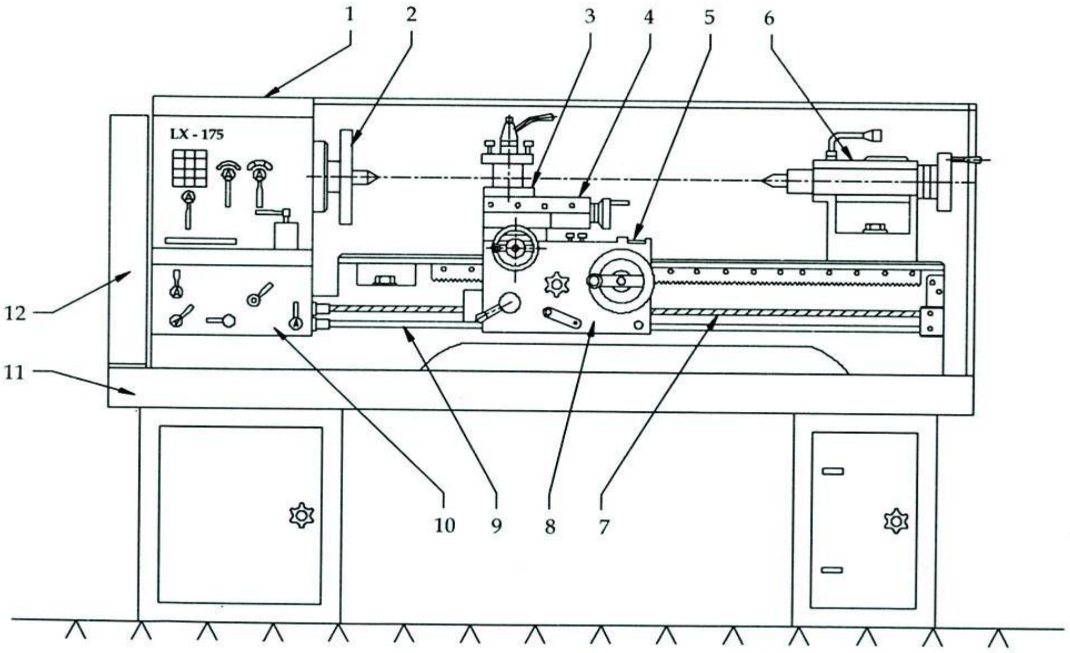
Turning process:

The various shapes of turned parts are obtained by different turning processes. The process of machining from the outside are known as “Outside Turning” and from the inside as “Inside Turning”. The work pieces are given cylindrical shape by longitudinal turning, plane surfaces by facing or transverse turning, tapers by taper turning, profiles by profile turning and threads by thread cutting.

OUTSIDE TURNING **INSIDE TURNING**



MAIN PARTS OF THE LATHE MACHINE



1	Head Stock	5	Saddle With Cross Slide	9	Feed Shaft
2	Chuck Plate	6	Tail Stock	10	Norton Gear Box
3	Tool Post	7	Lead Screw	11	Tray
4	Compound Slide	8	Apron	12	Side Cover

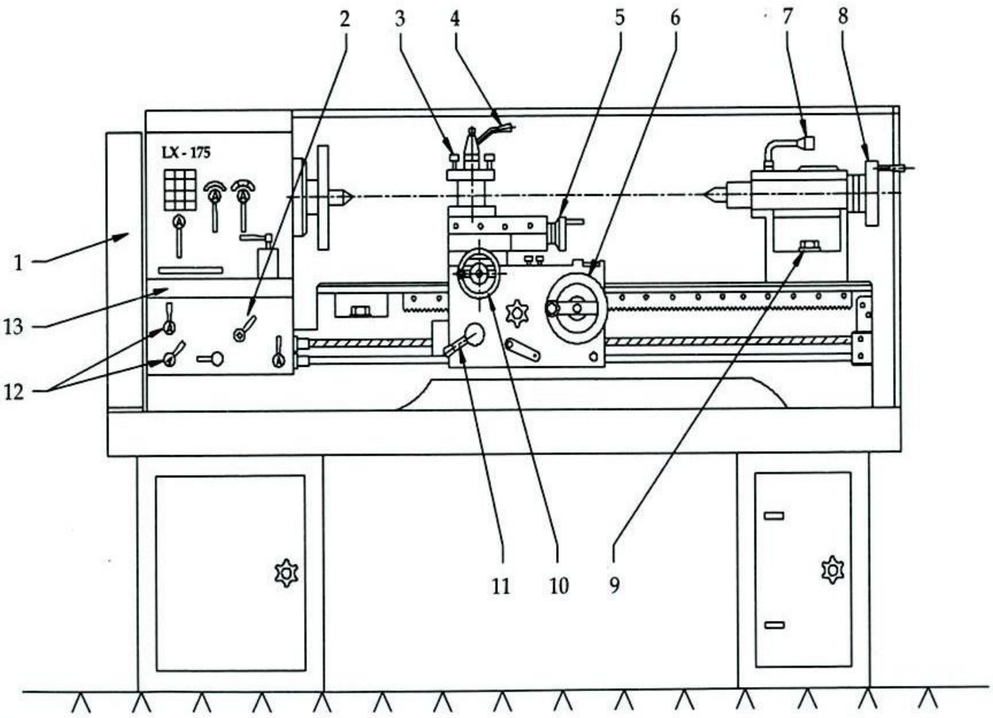
Lathe specifications

1. The maximum diameterof a work that is held between centres.
2. The swing over the bed (this is the perpendicular distance from the lathe axis to top of the bed).
3. The length of the bed.
4. The length of the bed ways & type.
5. The maximumlength of work that can be turned b/n centers.
6. The range of threads that can be cut.
7. The capacity of lathe (Motor).
8. Range of spindle speed.
9. Range of feed.
10. Size of the spindle nose and types of spindle nose.

INTRODUCTION TO MAIN PARTS OF THE LATHE MACHINE

Sl. No.	Parts		Description
1.	Head stock	:	Head stock is one type of gear box & it is the heart of the machine. Which gives various speed by means of gear arrangement. The gear change lever is given in the head stock body to change the speed.
2.	Chuck Plate	:	Chuck plate is provided to mount the chuck on it.
3.	Tool Post	:	Tool post is mounted on the compound slide, which is used to hold the tools.
4.	Compound Slide	:	Compound slide is used to give angular & small longitudinal motion to the tool.
5.	Saddle & Cross Slide	:	Cross slide is mounted on the saddle. Cross slide give transverse motion whereas saddle gives longitudinal motion.
6.	Tail Stock	:	Tail stock is used to hold the job for between centre turning.
7.	Lead Screw	:	Lead screw is used for threading operation. Which is also known as thread shaft.
8.	Apron	:	Apron is a gear box which gives automatic feed to the carriage.
9.	Feed Shaft	:	Feed shaft is used for auto feeding.
10.	Norton gear box	:	Norton gear box is used to obtained metric as well as BSW thread in various pitch for threading operation.
11.	Tray	:	Tray is provided to collect the cutting fluid & chip when machine is in running condition.
12.	Side Cover	:	Side cover is provided in the back side of the machine for protection of gear train & for safety purpose.

BASIC CONTROLLING PARTS OF LATHE



1 R / F Speed Change Lever
2 Speed Change Lever
3 Tool Post Bolt
4 Tool Post Handle
5 Compound Hand Wheel
6 Apron Hand Wheel
7 Quill Clamping Lever
8 Tail Stock Hand Wheel
9 Clamping Bolt
10 Surface Hand Wheel
11 Half Nut Operating Lever
12 Norton Gear Box Opeating Levers
13 Operating Pannel

BASIC CONTROLLING PARTS

(1) R/F SPEED CHANGE LEVER

The function of this lever is to change the direction of motion of lead screw. It is advisable to operate this lever only after the machine stops.

(2) SPEED CHANGE LEVER

We can obtain 8 various speed as per our requirement by operating this lever. Don't operate this lever when the machine is in running condition.

(3) TOOL POST BOLT

The cutting tool is holding by these bolts. Always use spanner to tighten & loosen these bolts.

(4) TOOL POST HANDLE

During the turning process sometimes it is necessary to give an angle to the cutting tool. By means of this lever we can clamp the tool post at required position.

(5) COMPOUND HAND WHEEL

This hand wheel in longitudinal direction operates the compound upper side. A graduated dial ring is provided with this hand wheel. On this dial ring 1 division = 0.021mm.

(6) APRON HAND WHEEL

This hand wheel is used to give longitudinal travel to the carriage with surface and compound slide on the bed guide ways. On apron hand wheel 1 division = 0.200 mm.

(7) QUILL CLAMPING LEVER

By means of this lever, tailstock quill can be clamped in required position.

(8) TAIL STOCK HAND WHEEL

This hand wheel operates the tailstock quill. The graduated dial ring is provided on this hand wheel. On this dial ring 1 division = 0.050 mm.

(9) CLAMPING BOLT

The function of this bolt is to locate the tail stock body at required position on the bed guide ways.

(10) SURFACE HAND WHEEL

This handle operates the surface in transverse direction. A graduated dial ring is provided on this hand wheel. On this dial ring 1 division = 0.10 mm.

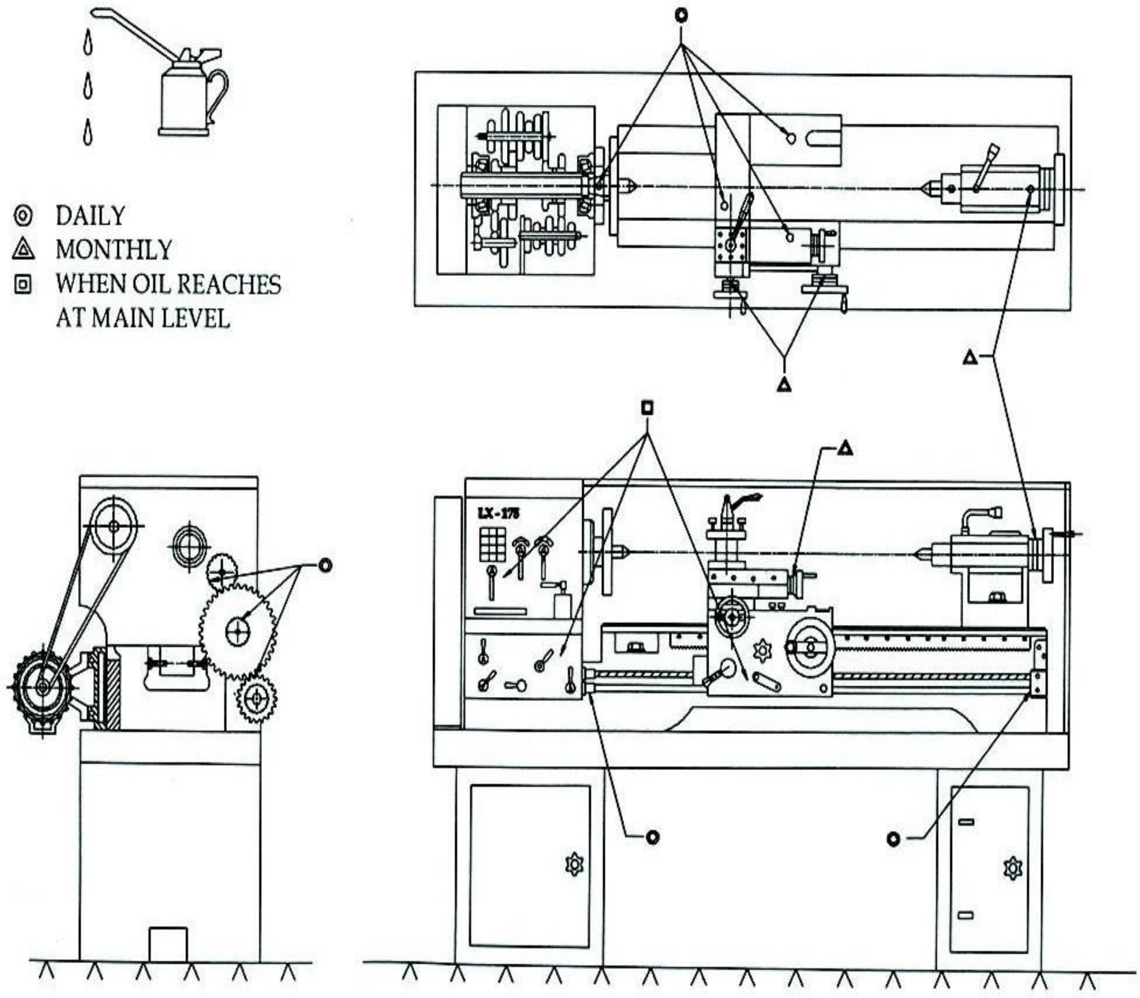
(11) HALF NUT OPERATING LEVER

This lever is used to engage or disengage the lead screw while threading operation is performed.

(12) NORTON OPERATING LEVERS

Norton gear box is operated by means of this lever so that various pitch of thread can be selected.

LUBRICATION CHART



LUBRICATION

Proper lubrication is very important. The accuracy of the lathe depends on the proper and regular lubrication. Lubrication instructions are displayed in a lubrication chart.

If the lubrication is neglected then the bearing surfaces may damage, impairing the accuracy and shortening the life of the machine.

Before putting the machine in operation, all the Oil cups, Apron, Norton Gear Box & Head stock should be checked and filled with oil until the oil reaches the "Red Line" in the oil sight glass.

ASSEMBLY WISE LUBRICATION INSTRUCTION

(1) HEAD STOCK

- Threads on the spindle nose should be always cleaned and oiled before mounting the chuck plate or faceplate.
- Head stock body should be filled with oil. The level of the oil should be always maintained. The oil used for head stock is EP – 90 Gear Oil.
- Oil nipple, on the various parts like brackets. etc. must be properly filled with oil.

(2) TAILSTOCK

- There are two oil holes plunged by oil cup and by oil nipple. Oil cup carry oil to the housing and tailstock quill.

(3) APRON

- A hole is provided in the front face of apron to pour oil in apron. Pour the oil till level comes up to the "Red Mark" on the oil sight glass of the apron. The oil used for apron is EP–140 Gear Oil.
- All the rotating parts and bearings of the apron are splash lubricated. An oil-drain plug is provided at the bottom to change the oil

(4) SADDLE

- Two oil cups are provided on the top face of the saddle. Fill these cups with oil daily. Oil flows and reaches to the Flat and V- guide ways of the bed.
- Surfaces Screw should be lubricated by the nipple, which is given on the screw boss.
- Two oil nipples are provided on the top face of the surface slide, which carry oil in both the guide ways of the saddle.

(5) COMPOUND SLIDE

- Two oil nipples are provided on the front face of the compound slide, which carry the oil for both the guide ways of the slide.
- To oil the housing of the compound slide oil nipple is provided on the compound boss.

(6) LEAD SHAFT & FEED SHAFT

- Clean the lead shaft, feed shaft & rack with the cotton waste daily & oil the same properly.
- Both lead screw brackets (Front and Rear) having an oil nipple on the tiny top face, which supply oil to the bearing and housing.

(7) NORTON GEAR BOX

- Norton gear box should be filled up by Gear EP–90 to get proper efficiency of the gear box. An oil sight glass is provided on the Norton to check the oil level. Change the oil when it is required.

(8) GUIDE WAYS

- Before starting the lathe, operator should always clean both the guide ways of the bed thoroughly and should oil properly.

PROBLEMS & ITS REMEDIES

Sl. No.	Problem	Remedies
1.	Inaccurate turning	❖ Check proper grouting of the machine ❖ Check proper leveling of machine. ❖ Put proper support by steady rest; follow rest of centre support by tailstock. ❖ Clamp cutting tool firmly with less over hanging. ❖ Set proper speed & feed and use proper grade of tool
2.	Vibration produced during turning	❖ Tight the spindle check nut & check the hotness of bearing
3.	Noise in gear train end feed mechanism	❖ Check that gears are matching properly with correct backlash. ❖ Check any damages marks on the gear teeth. ❖ Lubricate gear train at all points thoroughly.
4.	The depth of cut changes at the time of longitudinal feed	❖ Check the depth of cut, if excess reduce it. ❖ Adjust the wedges of the surface and compound slide.
5.	Difficulty in tracking heavy cuts	❖ Check the belt tensions if loose adjust the same for required tension. ❖ Check whether the automatic feed engaging star nut given in the apron is tightened
6.	Apron and carriage assy. Slide move tightly on the bed ways	❖ Clean the sliding surfaces and lubricate it thoroughly ❖ Loose the carriage clamping screw if it is tight ❖ Check the machine level.
7.	Threading Overlaps	❖ Check the lead screw play and half nut play. If the play is more adjust the same. ❖ Check and change gear train as per thread chart.

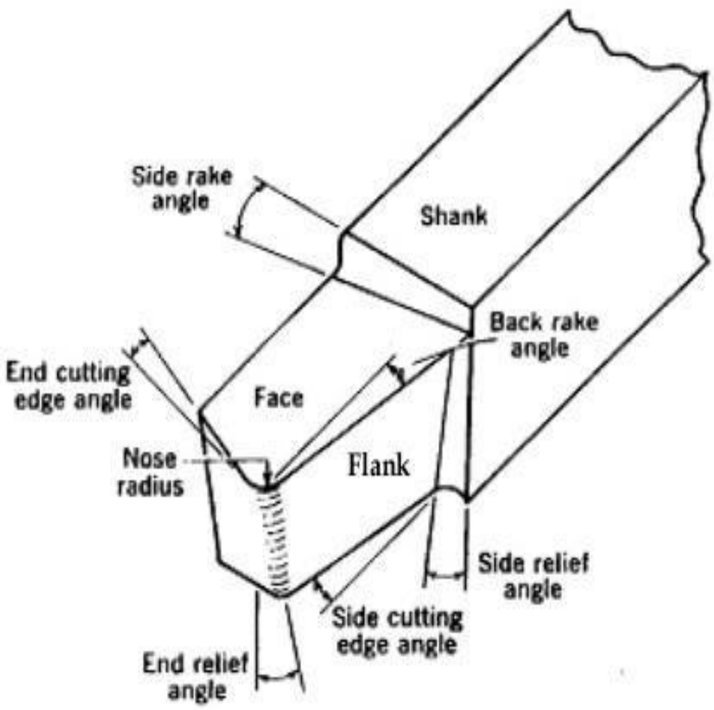
Cutting tool signature

The signature is a sequence of numbers listing the various angles in degrees, and the size of nose radius. The seven elements that comprise the signature of a single point cutting tool stated in the following order:

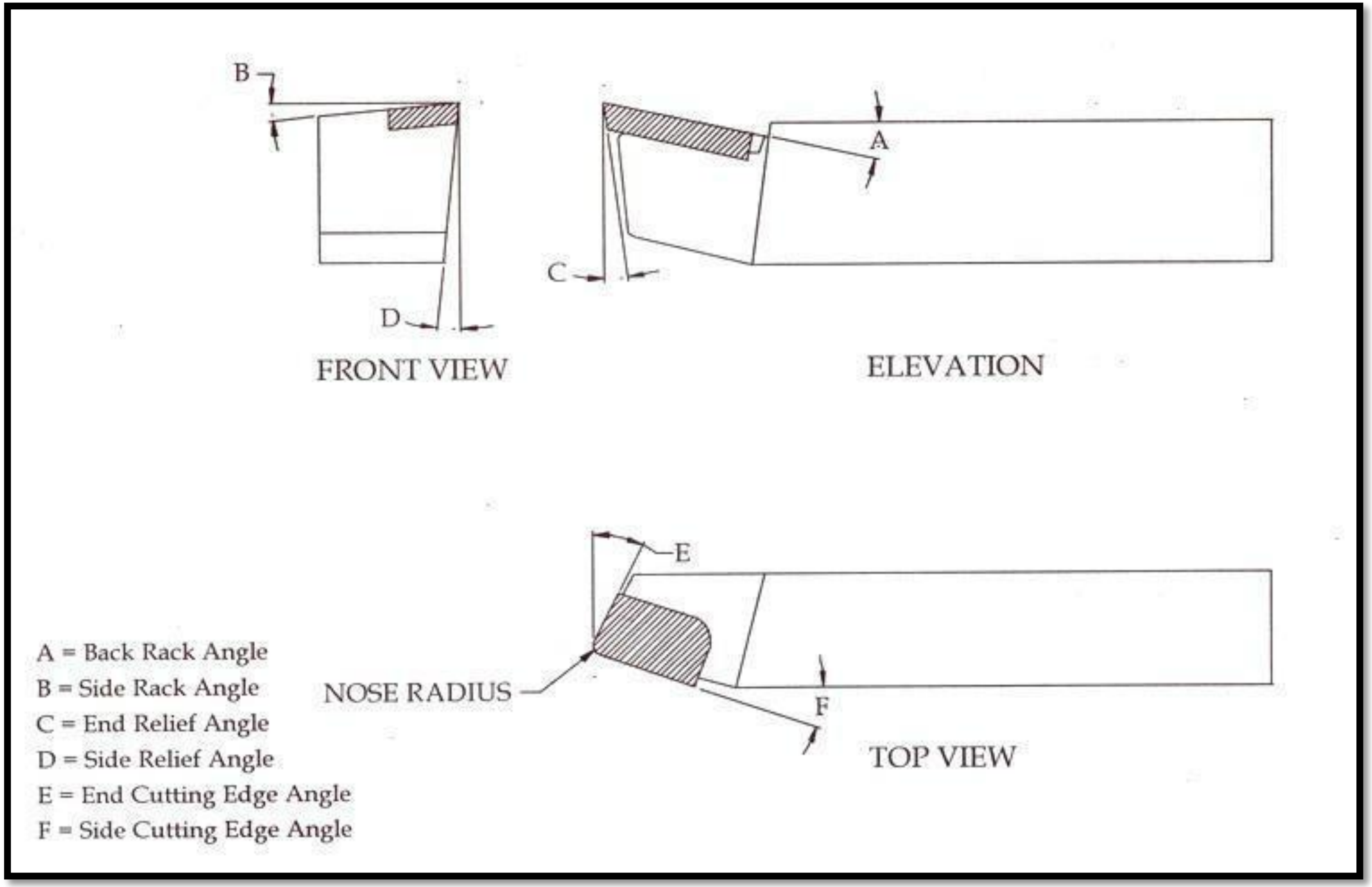
8 – 14 – 6 – 6 – 6 – 15 – 4

has 8^0 back rake angle, 14^0 side rake, 6^0 end relief, 6^0 end or side relief, 6^0 end cutting edge and 15^0 side cutting edge angles and 4 mm nose radius.

Tool signature for single point cutting tool:



TOOL GEOMETRY



A = $12^0 – 14^0$, B = $12^0 – 14^0$, C = 6^0, D = 6^0, E = 30^0, F = 12^0

TOOL GEOMETRY & SELECTION CHART

Material	Hardness HRB	High speed steel (Angle in Degree)					Carbide tools(Angle in Degree)						
		A	B	C	D	E & F	Brazed A	Brazed B	Trow way A	Trow way B	C	D	E & F
Alloy Steels, Carbon steels, High strength steel Tools steels, Nitriding & Structural Steel etc.	85-225	10	12	5	5	15	0	6	-5	-5	5	5	15
	225-325	8	10	5	5	15	0	6	-5	-5	5	5	15
	325-425	0	10	5	5	15	0	6	-5	-5	5	5	15
	45-58 HRC	0	10	5	5	15	-5	-5	-5	-5	5	5	15
Wrought free machining stainless steel	135-275	50	8	5	5	15	0	6	-5	-5	5	5	15
	275-425	0	10	5	5	15	0	6	-5	-5	5	5	15
Gray cast iron, Ductile cast iron, Malleable cast iron	100-200	5	10	5	5	15	0	6	-5	-5	5	5	15
	200-300	5	8	5	5	15	0	-5	-5	-5	5	5	15
	300-400	5	5	5	5	15	-5	-5	-5	-5	5	5	15
Wrought & Cast Aluminum Alloy	30-150 500 Kg	20	15	12	10	5	3	15	s0	5	5	5	15
Wrought & Cast Copper Alloy	40-200 500 Kg	5	10	8	8	5	0	0	0	5	5	5	15
Wrought & Cast Nickel Alloy Thermo plastics Thermosetting	80-360	8	10	12	12	5	0	6	-5	-5	5	5	15
	All	0	0	20-30	15-20	10	0	0	0	0	20-30	15-20	10
	All	0	0	20-30	15-20	10	0	15	0	15	5	5	15

NOTE:-Nose radius and cutting edge angle will generally be dedicated by type of operation being performed when not specified, use 1.2 mm nose radius.

APPLICATION OF CUTTING TOOLS

Sl. No.	Application	Range of Application	Feed
1	**TURNING**		
	(a) Straight Turning L.H.	External Turning	Longitudinal
	(b) Straight Turning	-do-	-do-
	R.H.		
	(c) Off-Set Turning L.H.	External turning & facing	Cross & Longitudinal
	(d) Off-Set Turning R.H.	-do-	-do-
	(e) Turning	External turning & facing	Longitudinal
	(f) Turning	External turning & facing shoulders at an angle of 90^o to work axis	Longitudinal
2	**FACING**		
	(a) Off-Set Facing	Turning shoulders at an angle of 90^o to face	Cross
3	**CUTTING OFF**		
	(a) Cut-Off	Cutting of blanks	Cross
	(b) Finish Shovel nosed	External Finish Turning	---
4.	**BORING**		
	(a) Boring	For Through hole	---
		Boring	
	(b) Boring	For blind hole boring	Longitudinal
5.	**FORMING**		
	(a) Form Tool	For Form Turning	Cross
6.	**THREADING**		
	(a) Threading	External Threading	Longitudinal
	(b) Threading	Internal Threading	Longitudinal

NORTON THREAD CHART

T pi	A	C	KNOB	LEVER
4	33	88	8	BC
4.5	33	88	7	BC
5	33	88	6	BC
5.5	33	88	5	BC
6	33	88	4	BC
6.5	33	88	3	BC
7	33	88	2	BC
7.5	33	88	1	BC
8	33	88	8	AC
9	33	88	7	AC
10	33	88	6	AC
11	33	88	5	AC
12	33	88	4	AC
13	33	88	3	AC
14	33	88	2	AC
15	33	88	1	AC

TPI	A	C	KNOB	LEVER
16	33	88	8	BC
18	33	88	7	BC
20	33	88	6	BC
22	33	88	5	BC
24	33	88	4	BC
26	33	88	3	BC
28	33	88	2	BC
30	33	88	1	BC
32	33	88	8	AC
36	33	88	7	AC
40	33	88	6	AC
44	33	88	5	AC
48	33	88	4	AC
52	33	88	3	AC
56	33	88	2	AC
60	33	88	1	AC

4:3 RATIO, 4 TPI LEAD SCREW CHANGE GEARS			
33	41	88	39

PITCH	A	C	KNOB	LEVER
0.5	39	88	1	AD
0.625	39	88	4	AD
0.75	39	88	6	AD
0.875	41	88	7	AD
0.937	39	88	8	AD
1	39	88	1	BD
1.25	39	88	4	BD
1.5	39	88	6	BD
1.75	41	88	7	BD
1.875	39	88	8	BD
2	39	88	1	AC
2.5	39	88	4	AC
3	39	88	6	AC
3.5	41	88	7	AC
3.75	39	88	8	AC
4	39	88	1	BC
5	39	88	4	BC
6	39	88	6	BC
7	41	88	7	BC
7.5	39	88	8	BC

INFLUENCE OF TOOL ANGLES

The amount of rake angle to be given in a tool depends on the following factors:

1. Type of material to be cut
2. Type of tool material being used
3. Depth of cut
4. Rigidity of the tool holder and condition of machine.

Rake: The rake is the slope of the top away from the cutting edge. The larger the rake angle, the larger the shear angle, and thereby the cutting force and power reduce. Large rake gives good surface finish.

Back rake angle: Back rake indicates that the plate which forms the face or top of a tool has been ground back at an angle sloping from the nose.

Side rake angle: Side rake indicates that the plane that form the face or top of a tool has been ground back at an angle sloping from the side cutting edge.

Nose: The nose of a tool is the conjunction of the side- and end- cutting edges. A nose radius increases the tool life and improves surface finish.

Flank: The flank of a cutting tool is that surface which face the workpiece.

Shank: The shank is that portion of the tool bit which is not ground to form cutting edges and is rectangular in cross-section.

Face: The face of the cutting-tool is that surface against which the chip slides forward.

End relief or clearance angle: Indicates that the nose or end of a tool has been ground back at an angle sloping down from the end cutting edge.

Side relief or clearance: Indicates that the plane that forms the flank or side of a tool has been ground back at an angle sloping from the side cutting edge.

End cutting edge angle: Indicates that the plane which forms the end of a tool has been ground back at an angle sloping from the nose to the side of the shank.

Side cutting edge angle: Indicates that the plane which forms the flank or side for a tool has been ground back at an angle to the side of the shank. Chips are removed by this cutting edge.

FEED CHART (mm/rev.)

POSITION BC		
Lever	**Longitudinal**	**Traverse**
1	0.42	0.11
2	0.46	0.12
3	0.51	0.13
4	0.55	0.14
5	0.61	0.15
6	0.66	0.17
7	0.76	0.19
8	0.85	0.21

POSITION AC		
Lever	**Longitudinal**	**Traverse**
1	0.21	0.05
2	0.22	0.06
3	0.24	0.062
4	0.27	0.07
5	0.30	0.08
6	0.34	0.09
7	0.38	0.10
8	0.51	0.14

Example:

To cut 3 mm Pitch with The help of the “Norton Gear Box” Knob ‘Position’ must be as below:

1) Top Knob in “A” Position
2) Bottom Knob in “C” Position.
3) 1 to 8 no. Star Knob (R. H. Side) in “6” Position.
4) ‘ Disengage – Engage Lever’ in “Engage” Position
5) N.B.: only use the gear $\frac{A}{C} = \frac{39}{88}$ Of Last Line for Threading the Same Line.

Cutting speed:

The speed at which the cutting edge passes over the material, which is expressed in meters per minute.

Cutting speed, V = meters/min

Where: V = Cutting speed in Meter/minute.

Π = 3.14

D = Diameter of work piece in mm

N = rpm

Example: Find out the cutting speed to turn 50 Ø bar at 160 rpm.

V = 3.14 x 50 x 160 / 1000

V = 25 Meter/minute.

Feed:

The feed of the tool is the distance it moves along the work for each revolution of work and it is expressed in mm/rev.

Factors governing the cutting speed

- Finish required
- Depth of cut
- Tool geometry
- Properties and rigidity of the cutting tool & its mounting
- Properties and rigidity of work piece material
- Type of cutting fluid used
- Rigidity of the machine tool

Factors governing the feed

- Tool geometry
- Surface finish required in the work
- Rigidity of the tool
- Coolant used

Turning time calculation

The time required for a cut is found by,

Time to turn = mins.

Example:

1) A mild steel Ø40 mm and 100 mm length has to be turned to Ø30 mm in one cut for full length using a HSS tool with a feed rate of 0.2 mm/rev, determine the turning time.

Turning time =

= 100 x 1/ 0.2 x 238.6

= 2.09 minutes

(or)

= 2 minutes 5.4 seconds

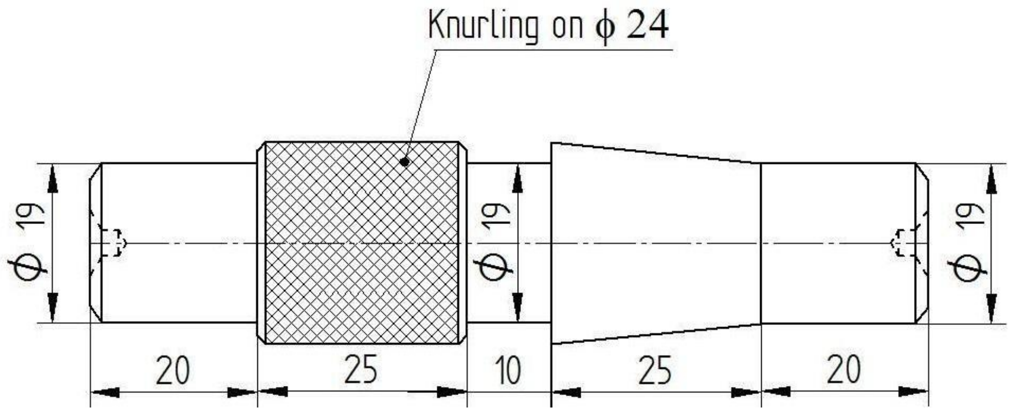
Exercises:

2) Find the time required for one complete cut on a piece of work 350 mm long and 50 mm in diameter. The cutting speed is 35 m/min and the feed is 0.5 mm per revolution.

3) A steel shaft of 25 mm diameter is turned at a cutting speed of 50 m/min. Find the rpm of the shaft.

TURNING MODELS

MODEL No. 01



Note: All dimensions are in mm only

Material: M S bright rod

Size: Ø25 x 105 Length

Tolerance: ±0.50

Taper Turning Calculation

A)

$$Tan\theta = (D - d) / 2l$$

$$= (24 - 19) / 2l$$

$$= (24 - 19) / 2(25)$$

$$\theta = \_\_\_\_\_\_\_\_\_$$

MODEL No. 01

Tools required	Operations
1. Facing / turning tool	1. Facing
2. Undercutting tool	2. Counter sinking
3. Combination centre bit	3. Plain turning
4. Knurling tool	4. Step turning
5. Vernier caliper	5. Chamfering
	6. Grooving
	7. Taper turning
	8. Knurling

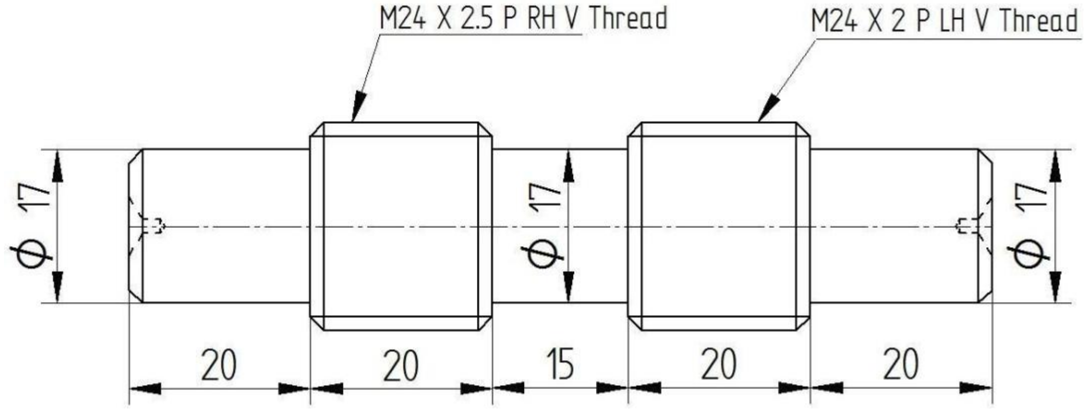
Procedure: (1st step)

1. Study the drawing
2. Hold the workpiece on 3 jaw chuck by keeping 60 to 70 mm outside and face the workpiece to clear the roughness
3. Center drilling on the face of the work
4. Plain turn Ø24 to maximum length
5. Step turn Ø19 to 20 mm length
6. Undercut Ø19 to 10 width
7. Taper turning
8. Chamfering 0.5 all sharp corners

(2nd step)

1. Reverse hold the job on Ø19 and face to maintain total length 100 mm
2. Centre drilling
3. Step turn diameter 19 for a length of 20 mm
4. Turn diameter 23.7 mm for knurling to a length of 25 mm
5. Chamfer 0.5 mm all sharp corners
6. Take the revolving centre support
7. Form the knurling on diameter 23.7 by using diamond knurling tool
8. Chamfer knurled corners

MODEL No. 02



Note: All dimensions are in mm only

Material: M S bright rod

Size: Ø25 x 105 Length

Tolerance: ±0.50

Blank size for thread cutting

Blank size = Major diameter – ——

= 24 - __

=24 – 0.2

= 23.8 mm

Blank size = Major diameter – ——

= 24 – __

=24 – 0.25

= 23.75 mm

MODEL No. 02

Tools required	Operations
1. Facing/ plain turning tool	1. Facing
2. Undercutting tool	3. Counter sinking
3. Combination centre bit	4. Plain turning
4. V threading tool	5. Step turning
5. Vernier caliper	6. Under cutting
6. Screw pitch gauge	7. chamfering
7. Center gauge	8. Threading

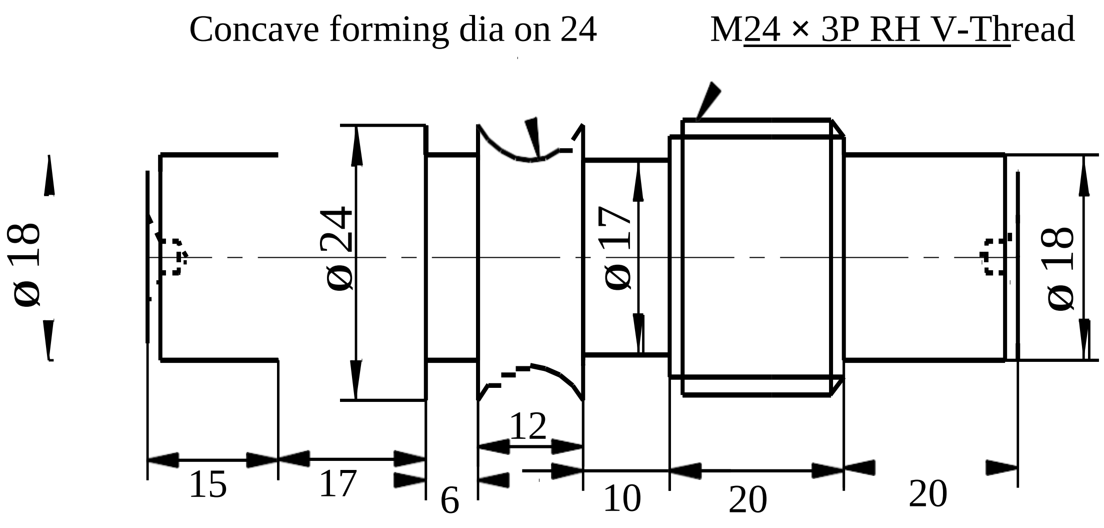
Procedure: (1st step)

1. Study the drawing.
2. Hold the workpiece on 3 jaw chuck by keeping 60 to 70 mm outside and face the workpiece to clear the roughness.
3. Face the job and counter sinking at one end.
4. Plain turning the job to Ø23.8 to maximum length.
5. Step turning to Ø17 for a length of 20 mm.
6. Under cut the dia 17 for a length of 15 mm as per the sketch.
7. Threads to be cut on diameter 23.8 mm for a length of 25 mm.

(2nd step)

1. Reverse hold the job on Ø19 and face to maintain total length 100 mm
2. Centre drilling
3. Step turn diameter 17 for a length of 20 mm
4. Turn diameter 23.75 mm for threading to a length of 20 mm
5. Chamfer 0.5 mm all sharp corners
6. Take the revolving centre support
7. Threads to be cut on diameter 23.8 mm for a length of 25 mm.

MODEL No. 03



Note: All dimensions are in mm only

Material: M S bright rod

Size: Ø25 x 105 Length

Tolerance: ±0.50

MODEL No. 03

Tools required	Operations
1. Facing/ turning tool	1. Facing
2. Under cutting tool	2. Counter sinking
3. Form turning tool	3. Step turning
4. V threading tool	4. Threading
5. Vernier caliper	5. Form turning
6. Screw pitch gauge	
7. Center gauge	

Procedure: (1st step)

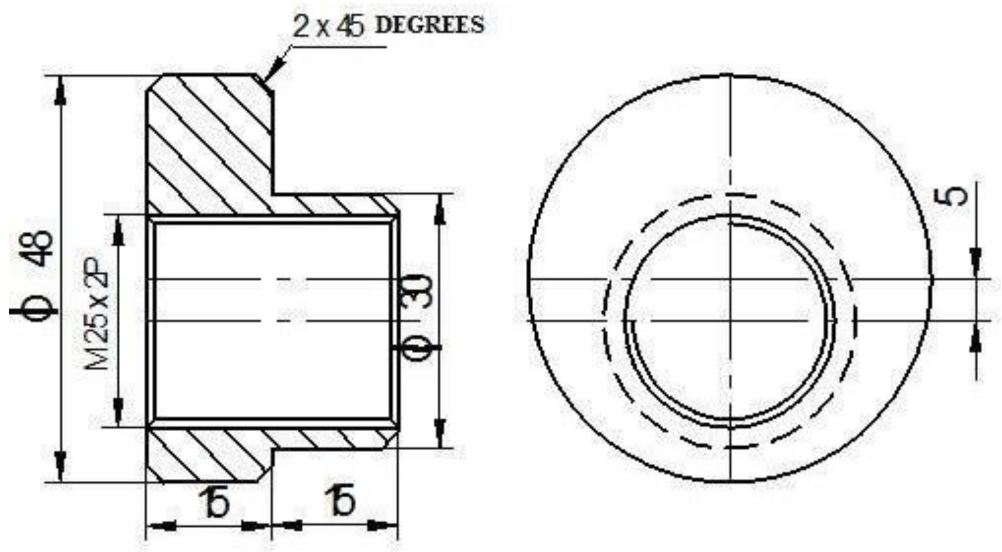
01. Study the drawing.
02. Hold the workpiece on 3 jaw chuck by keeping 60 to 70 mm outside and face the workpiece to clear the roughness.
03. Face the job and counter sinking at one end.
04. Plain turning the job to Ø23.7 to maximum length.
05. Step turning to Ø17 for a length of 20 mm.
06. Under cut the dia. 17 for a length of 10 mm as per the sketch.
07. Threads to be cut on diameter 23.7 mm for a length of 20 mm.

(2nd step)

01. Reverse hold the job on Ø17 and face to maintain total length 100 mm
02. Centre drilling.
03. Step turn diameter 18 for a length of 20 mm.
04. Under cutting diameter 18mm for a length of 6 mm as per the sketch.
05. Concave shape is to be formed by using forming tool as per the sketch.

MODEL No. 04

[Eccentric turning with internal threading]



Note: All dimensions are in mm only

Material: M S bright rod

Size: Ø50 x 35 Length

Tolerance: ±0.50

MODEL No. 04

Tools required	Operations
1.Facing tool	1.Facing
2.Turning tool	2.Turning
3. Vernier height gauge	3. Drilling
4. Try square	4. Boring
5. Centre punch	5.Ecentric turning

Procedure:

1. Study the drawing.
2. Set the cutting tool for centre height.
3. Prepare the work piece for the Ø 48mm and to a length of 30 mm.
4. Mark the work piece center with the help of Vernier height gauge and V block with ‘C’ clamp and try square.
5. Mark the 5 mm offset from centre of Ø48 mm by using Vernier height gauge and V block.
6. Punch the eccentric centre point with the help of centre punch.
7. Hold the job in four jaw chuck and true the job to eccentric centre point with the help of dead centre.
8. Do eccentric turning to a Ø30 mm to a length of 15 mm (use slow speed)
9. With the help of centre bit and drill bit drill the hole to the eccentric point Ø18 mm hole and bore it up to Ø23.8 mm.
10. Do internal threading by using internal threading tool.
    Hole size (Minor Ø) = Major Ø – 2 x depth of thread
    = 25 – 2 x 0.61
    = 25 – 1.22
    = 23.78 = 23.8
11. Finally check the dimensions as per given drawing.

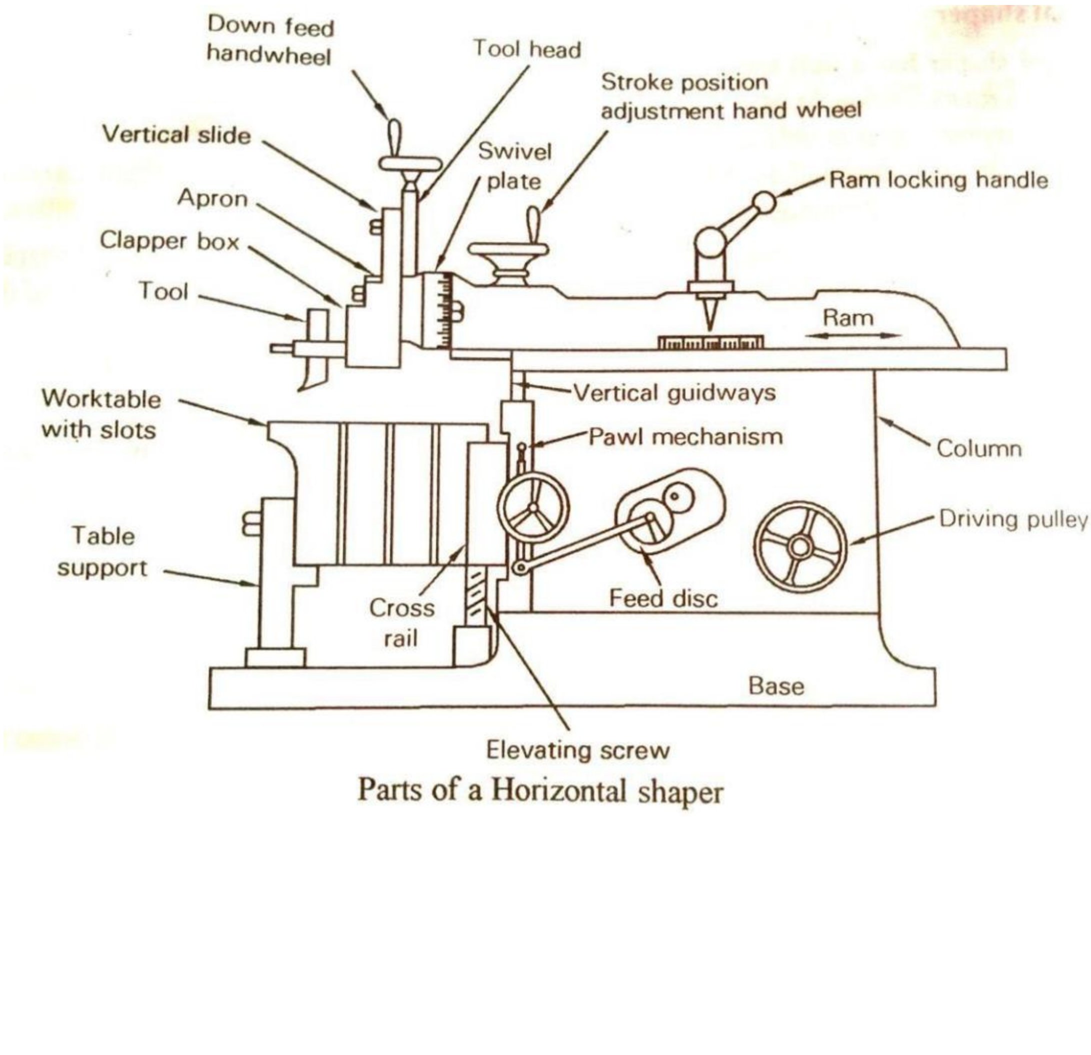
SHAPING

Shaping is a process of removing metal from surfaces in horizontal by the use of single point tool held in a ram that reciprocates the tool in a linear direction across the work pieces.

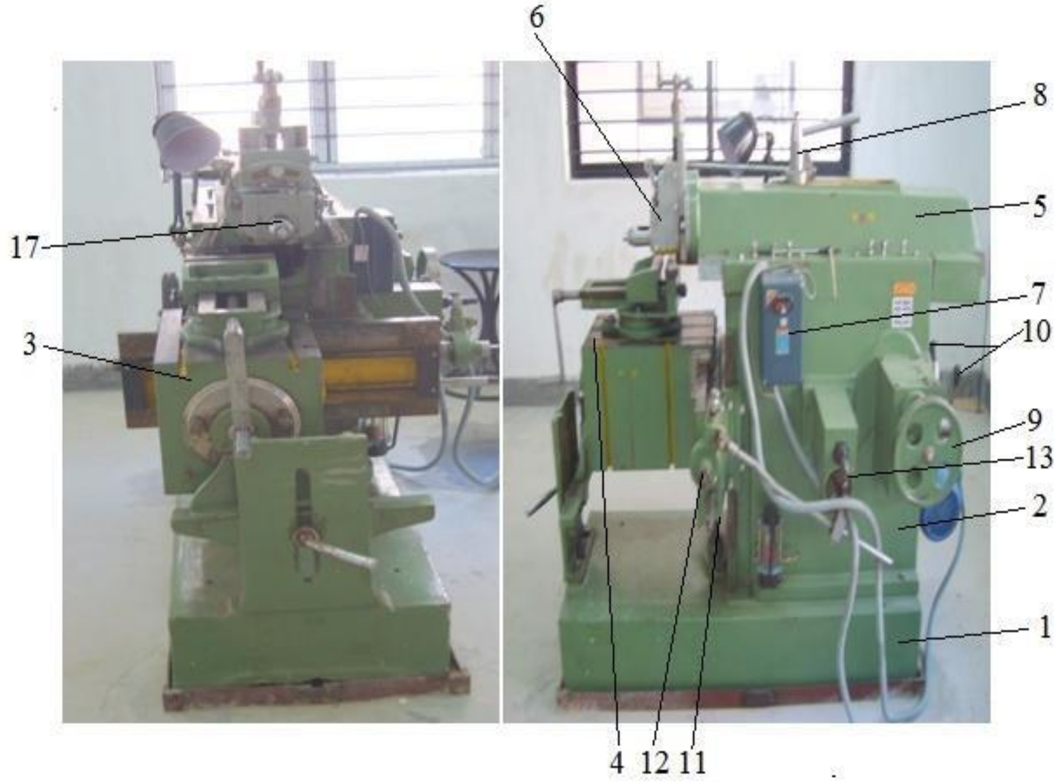
Application of shaping machine

To manufacture guide gibs, dovetail and V block etc….

Shaping machine



Parts of a Horizontal shaper



Front view **Side view**

Principle parts of a shaper

Sl. No.	Parts	Description
01	**Base**	It is a heavy cast iron body that support all other parts of machine
02	**Column or pillar**	It houses, driving motor, control devices, mechanism of driving the ram and work table. At top of the column the ram reciprocates cross rail vertically along these guides ways
03	**Cross rail and saddle**	It can be raised or lowered by means of elevating screw to accommodate work piece of different height. It carries the table cross feed screw together with the pawl and ratchet drive mechanism.
04	**Table**	The table is provided with T- slots on its top and on its side for clamping the work piece. The front face of the table is supported by an adjustable table support to with stand the weight of the work piece and cutting action during operation.
05	**Ram**	The ram is a rigidly braced casting, the ram reciprocates on the guide ways.
06	**Tool head**	The tool head is mounted at the front end of the ram. The tool head holds the tool, the necessary vertical and angular feed movement

Operating controls of a shaping machine

Sl. No.	Controls	Function
07	**Main switch**	Power supply to shaper in main electrical panel.
08	**Starter**	ON & OFF switch control to run or stop the shaper.
09	**Ram locking handle**	Stroke adjustment
10	**Ram and gear movement hand wheel**	To adjust the stroke length and change of speed gear box
11	**Speed changing levers (2 nos)**	For variation of stroke feed movement
12	**Spindle for elevating screw**	For vertical movement of the table
13	**Spindle for cross feed**	Cross feed movement of the table both by hand and pawl and ratchet drive mechanism (Auto feed movement).
14	**Spindle for ram stroke adjustment**	To set stroke length
15	**Hand wheel for tool head movement**	To give depth of cut to work piece
16	**Clapper box**	-------------
17	**Oil flashing unit**	-------------
18	**Tool locking bolt**	-------------

Specification of a shaper

- Maximum length of stroke of ram
- Maximum horizontal travel of work table
- Maximum vertical travel
- Dimension of table working surface
- Power of the motor

Accident prevention during shaping operation

- Before starting the machine, it should be continuously operated by hand in order to assure that ram or table does not strike anywhere.
- Carefully operate the vertical adjustment of the table by seeing the front supporting plate.
- Chips should be removed only by means of hook and brush.
- Measurement of the work piece should be taken only after the machine is stopped.

Sequence of operation plan to perform job in shaper

Sl. No.	Operations	Tools
01.	Mounting and aligning of work piece	Machine vice with steel parallels
02	Clamping of shaping tools	Grove tool
03	Setting the no. of cycles, stroke length, stroke position and feed.	-------------
04	Mark the block recesses and groves	Granite surface plate, vernier height gauge, V-block, centre punch, ball peen hammer, anvil
05	Successive shaping of longitudinal sides (cutting depth is set 0.5 mm in each cut)	Grooving tool
06	Rough shaping of V- block	Grooving tool
07	Setting tool slide at angle clamping of single pointed tool shaping oblique surface.	Single pointed tool
08	Setting tool slide into normal position	-------------

SHAPING MODELS

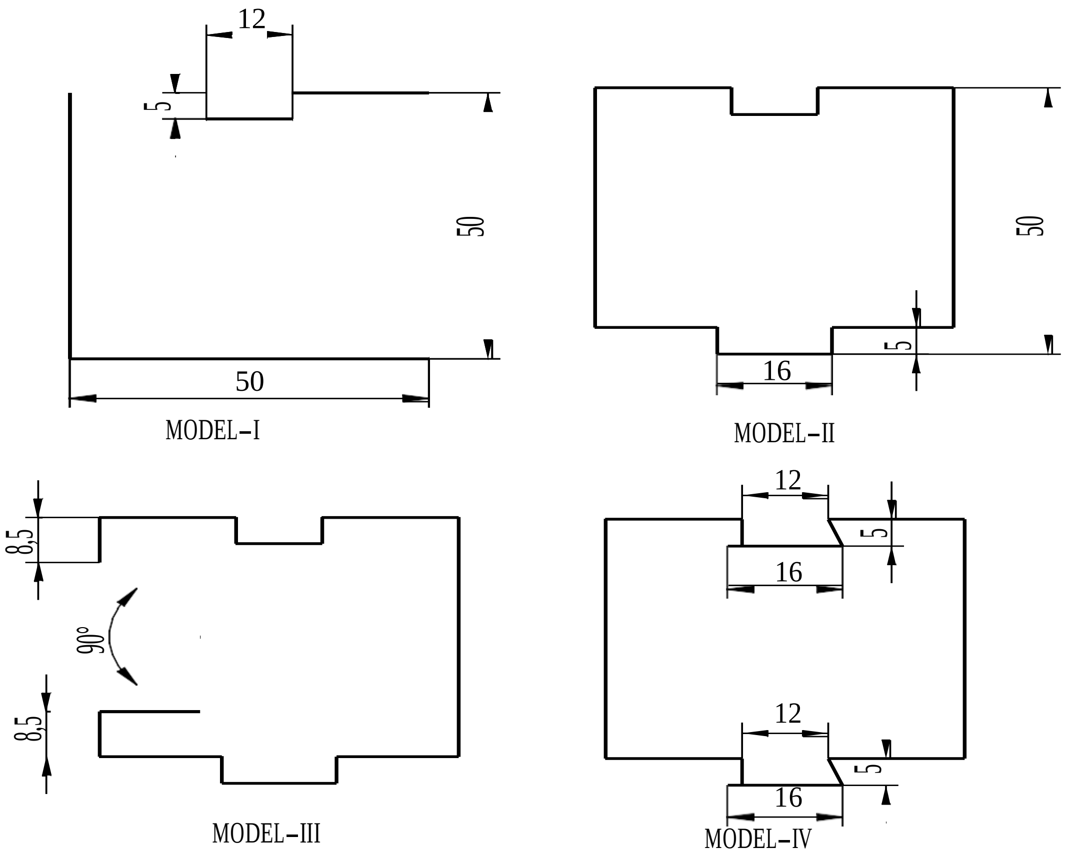
Aim – Prepare a 'V' block on a rectangular block on shaping machine

Apparatus – Vernier height gauge, steel rule, shaping tool, center punch, hammer, spanner set, and Vernier caliper.

Operation – Marking, shaping

Procedure –

1. Take the rectangular block of standard size and mark the dimension on the work.
2. Hold the job on the work holding device on a work table of a shaping machine.
3. Produce a slot on the work piece on 3 sides of the rectangular block as per drawing.
4. Rotate the tool head to an angle 45^0 and produce to V slot as per sketch.
5. Finish the job as per the sketch.



All dimensions are in mm

MILLING

It is a machining process in which metal is removed by rotating multiple-tooth cutters, as the cutter rotates each tooth removes a small amount of material from the advancing work for each spindle revolution. (The relative motion between work piece and cutter can be in any direction. Surface having any orientation can be machined in milling).

Practical applications

Machining of plane, curved surface, slots, groves, gears, teethes, guide gibs, bolt, splined shaft and ring nut are few example parts of milling operations.

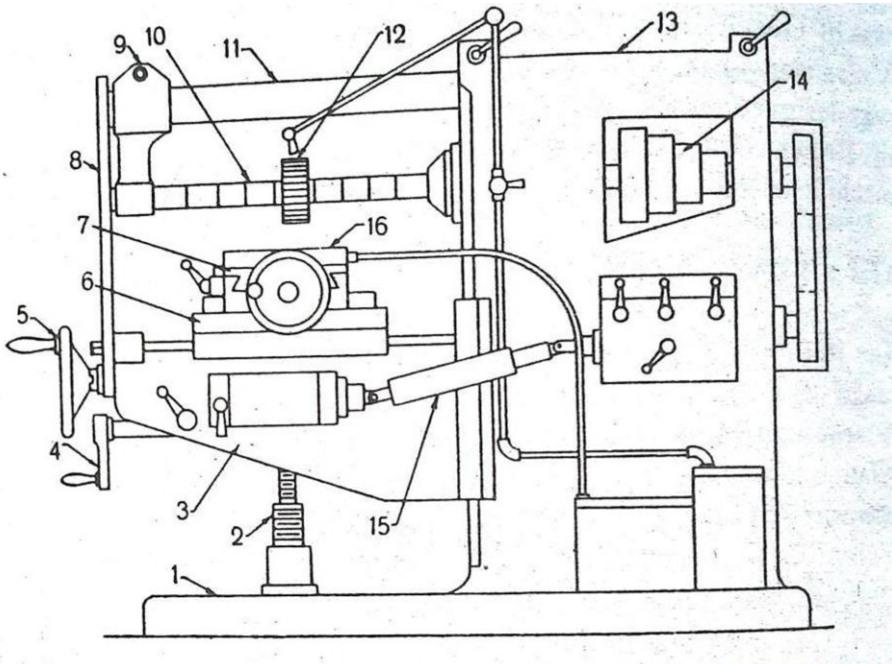
Principle parts of milling machine

1. Base
2. Column
3. Spindle with supporting arm
4. Over arm, supporting bracket
5. Knee
6. Saddle
7. Work table
8. Main drive
9. Feed drive
10. Vertical head spindle

Operating controls of milling machine

Sl. No.	Controls	Functions
11	Main switch	Power supply to milling machine
12	Push button starter	Starting and stopping of main motor
13	Levers for selecting spindle speed	Selection of suitable speeds
14	Levers for selecting feed drive	Selection of suitable speeds
15	Hand wheel for longitudinal feed or movement	Hand movement of table (longitudinal)
16	Hand crank for cross feed	Hand movement of table (cross)
17	Hand crank for vertical feed	Hand movement of the table (vertical)
18	Lever for auto feed movement	Auto movement both to and fro

MILLING MACHINE



Column and knee type milling machine

1. Base, 2. Elevating screw, 3. Knee, 4. Knee elevating handle, 5. Crossfeed handle, 6. Saddle, Table, 8. Front brace, 9. Arbor support, 10. Conepulley, 15. Telescopic feed shaft.

Front view **Side view**

Technical specification of milling machine

1. Over all surface of the table
2. Longitudinal traverse of the table hand/power
3. Cross travel of the table hand/power
4. Vertical travel of the table hand
5. Spindle nose to outer Arbor
6. No. of spindle speeds
7. Motor for spindle drive

<u>ATTACHMENTS FOR MILLING</u>

1. Universal Dividing Head

Universal dividing head is an important work holding and indexing device used on milling machine. With the help of the dividing head the work pieces can be accurately divided to any fraction of a revolution enabling the correct spacing of the grooves that can be machined on the periphery of the work piece.

Universal dividing heads find wide use in the production of spur gears, splines, helical gears, and other indexing requirements on a milling machine. In this method marking is not necessary.

Method of Indexing

1. Direct Indexing: Small no. of divisions

The Indexing takes place by rotating the dividing head spindle, where by the required divisions can be achieved through the relevant Index plate and indexing pin.

Operation Sequence

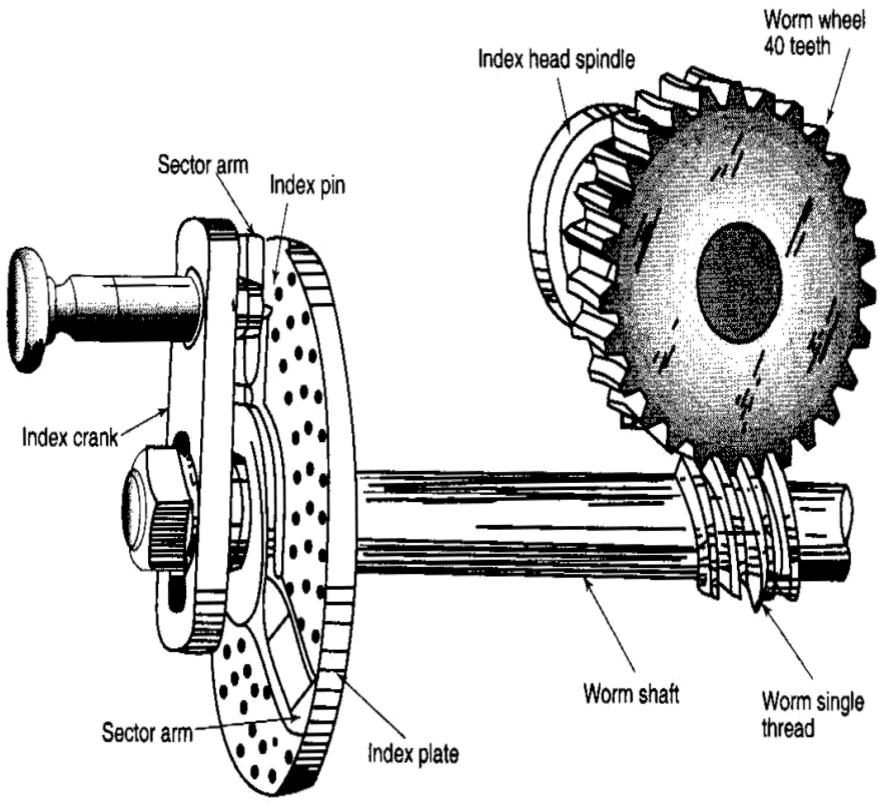
Worm and worm wheel must be disengaged by means of the disengaging lever., Loosen clamping lever, Release Index pin., Rotate the main spindle with the direct Index plate through the desired indexing holes.

Engage Index pin., Clamp lever tightened firmly, commence the milling process.

Divisions of direct indexing

1. Face with 24 Notches	2	3	4	6	8	12	24
2. Face with 5 and 7 Notches		5	7				

The reversing of notch plate can be done by losing the knurled nut.



Indexing method of a dividing head

2. Indirect Indexing: (Any No. Of Divisions)

The indexing process takes place through worm and worm wheel with the constant drive ratio of 1:40 with this drive ratio the following relation is given. One rotation of the main spindle requires 40 rotations of the Indexing lever.

Calculation of the required number of Index lever rotations

1. Full number of Index lever rotations are achieved when divisions of 40 by the required number of divisions, gives the full number

Example: Divisions required: 10

D: Number of Index lever rotations

IS: Dividing head constan

T = Divisions required

D = IS/t = 40/10 = 4

i.e., 4 rotation of the Index lever represents 1/10 rotation of DH Spindle

2. No full number is achieved, if the divisions are 40 from the required divisions. Then the index lever rotation must be further divided by using corresponding hole circle.

The hole circles of the double-sided index plate are as follows:

15-17-19-21-27-37-41-47

16-18-20-23-29-33-39-49

Example 1: Required number of division t = 29

Constant ratio = 1:40, Dividing head is Constant = 40

No. of Index lever rotations = D = IS/t = 40/29 = $1\frac{11}{29}$ i.e.

To achieve the desired no. of 29 division on the dividing head spindle, the Index lever must be rotated by 1 full rotation and 11 holes extra on the 29 hole circle.

Example 2: Required Number of Divisions t = 132

$$D = \frac{IS}{t} = \frac{40}{132} = \frac{\frac{40}{4}}{\frac{132}{4}} = \frac{10}{33} \text{ i.e.}$$

To achieve the desired number of 132 divisions on the dividing head spindle, the Index lever must be rotated by 10 holes on the 33-hole circle.

Example 3: Required number of divisions t = 9

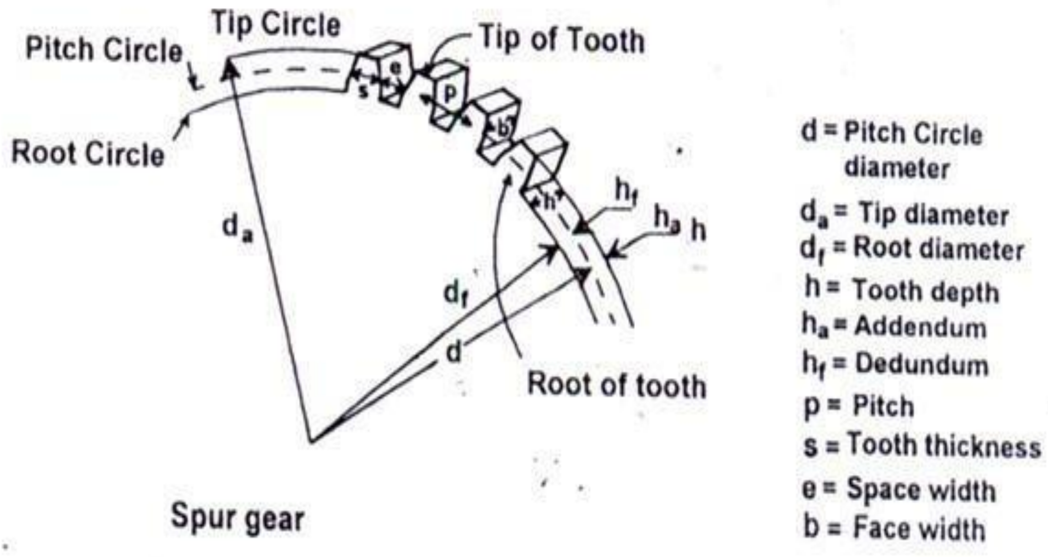
$$D = \frac{IS}{t} = \frac{40}{9} = \frac{40(3)}{9(3)} = \frac{120}{27} = 4.44 \text{ i.e.}$$

To achieve the desired number of divisions 9 on the dividing head spindle, the Index lever must be rotated by 4 rotation + 12 holes extra on the 27 holes circle.

Sequence of Operation

- Engage Worm and Worm wheel by means of the swing provided,. Set Index lever on the corresponding hole circle.
- Release Index into the marked hole on the selected hole circle.
- Set the first indicator to touch the index pin.
- Set the second indicator by rotating it over the number of holes and clamp the indicator by means of the clamping screws.
- Loosen clamping lever; rotate the index lever by the number of rotations and also by the no. holes and release the Index pin in last hole before the second indicator rotate the indicator set further until the first indicator rests on the Index pin tighten clamping lever and start the milling practice.

DIMENSIONS OF SPUR GEAR



The tooth form is limited by the tip and root circle

On the pitch circle tooth are spaced. The distance between the two teeth measured on the pitch circle is called the PITCH

The pitch is the product of constant and fig π.

The number with which π is multiplied is the MODULE (m)

Modules are standardized to a selected series. The Module is an absolute fig and the product in pitch is specified in mm.

Pitch = Module × π

P = m × π in mm

Module = ___________

Circular Pitch = ___________________

Module is a standardized quantity, whose purpose is to enable calculations with numbers, it is measured in mm.

Example: Calculate the pitch in mm for a module 2 = 2 × 3.14 = 6.28 mm

Since the pitch is a multiple of π simple figures are obtained for the pitch circle diameter.

Pitch circle diameter = module × no. of teeth

$d = m \times z$

Note: m = module

Z = no. of teeth

Teeth depth h = 13/6 m = 2.166 m = 0.7 p

Addendum h_a = 6/6 mm = 1 m = 0.3 p

Addendum h_f = 7/6 m = 1.166 m = 0.4 p

Tip diameter = $d_a = d + 2h_a$

(or)

$d_a = d + 2m$

(or)

$d_a = m \times z + 2m$

(or)

$d_a = m (z + 2)$ (mm)

(or)

Outside diameter: OD = m (z + 2) (mm) of the blank

Example: Calculate the following dimensions for a gear with module 2 and 30 teeth

Results: Pitch circle diameter = d = m × z = 2 × 30 = 60 mm

Addendum, $h_a = 1 m = 1 \times 2 = 2$mm

Dedundum, $h_f = 1.66 \times m = 1.166 \times 2 = 2.332$ mm

Tooth depth h = 2.166 × m = 2.166 == 2 = 4.332 mm

Tip diameter = $d_a = m(z + 2) = 2(30 + 2) = 64$ mm

Classification of the set of cutters,

Cutter No.	1	2	3	4	5	6	7	8
No. of teeth to be cut	135 To rack	55 To 135	35 To 54	26 To 34	21 To 25	17 To 20	14 To 16	12 To 13

A cutter for milling a particular type of gear is specified by diametrical pitch, pressure, angle, cutter no., and bore size of cutter.

MILLING MODEL

Aim – Spur gear cutting on a gear blank using milling machine.

Apparatus – Universal milling machine, gear blank mandrel, indexing head and Vernier caliper.

Operation – Facing, plain turning, drilling, boring, chamfering, gear cutting.

Procedure –

1. Mounting and aligning of the dividing head and tail stock on the horizontal milling machine.
2. Mounting of gear milling cutter on the cutter arbor and checking for concentric running.
3. Clamping of work piece between centre and setting to the centre of the cutter.
4. Adjusting the sector arms for the indexing head [dividing head]
5. Setting of revolution and feed for milling.
6. Cutter should have slightly on the work piece.
7. with drawing work piece out of range of the cutter and lifting.
8. Milling of first tooth space.
9. With drawing work from the cut, and turning the indexing handle by the tooth pitch, milling of the next tooth space.
10. Milling of remaining tooth.

GRINDING

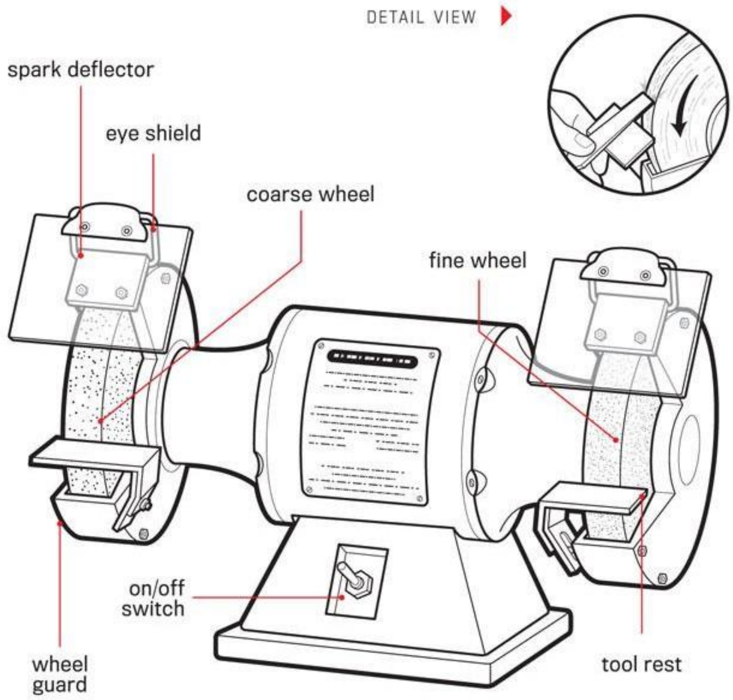
Grinding is the most common form of abrasive machining. It is a material cutting process that engages an abrasive tool whose cutting elements are grains of abrasive material known as grit. These grits are characterized by sharp cutting points, high hot hardness, chemical stability and wear resistance. The grits are held together by a suitable bonding material to give shape of an abrasive tool.

Practical applications

Surface finishing, slitting and parting, descaling, deburring, stock removal (abrasive milling) finishing of flat as well as cylindrical surface and grinding of tools and cutters and re sharpening of the same.

Bench Grinding Machine

A bench grinder is manually operated and normally has two wheels of different grain sizes that are fixed on a floor stand or work bench; to perform roughing and finishing operations. It is mainly used to shape tool bits; and repair or make various tools.



Principle parts of a Bench Grinder

Sl. No.	Parts	Description
01	**On/off switch**	Starting and stopping of main motor
02	**Coarse grain wheel**	It is generally used for roughing purposes
03	**Fine grain wheel**	It is generally used for finishing purposes
04	**Wheel guards**	The operator is protected against flying abrasive particles and ground material by the wheel guards
05	**Eye shield**	Safety glass shields are provided for additional protection against glares and flying particles.
06	**Tool rest**	A tool rest is provided for each wheel so that tools may be held or steadied while being ground

Specifications of Bench grinder

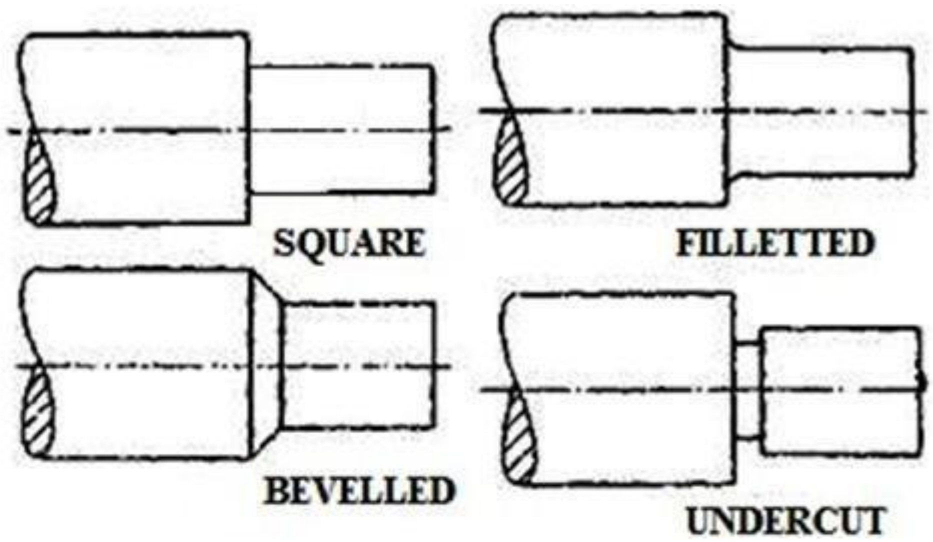
- Power rating of the electric motor
- Speed of the motor
- Abrasive grain size
- Size of the wheel

Procedure for Grinding

1. Examine the grinder to see that the tool rest is set at the required height, is within 1/8 of an inch to the face of the wheel.
2. Adjust safety glass shields on the grinder to permit clear vision of the part to be ground and still protect the operator from flying particles.
3. Start the grinder.
4. Hold the work in one hand, and steady it with the other. Place the work on the tool rest; then guide it against the face of the revolving wheel and apply enough pressure to grind.
5. Cool work in a water pot as it becomes heated from grinding, especially the small hardened tools that would lose their temper if overheated.
6. Check work with a gauge or other measuring tool.
7. Stop grinder.

Model No. 02

[Shoulder Forming]



Shoulder:

When ever more than one diameter is machined on a shaft, the section joining each diameter is called shoulder or step.

Purpose of shoulder forming:

- For mating parts to fit at right angles against the face of the step.
- To eliminate sharp corners.
- To give additional strength at the junction of steps.
- To give a good appearance.

Filleted shoulders are generally used on parts which require additional strength at the shoulder. The rounded corner is pleasing in appearance and also strengthens the shaft at this point without any increase in the diameter of the part.

VIVA -VOCE

1. What is machine?

A device consisting of fixed and moving parts that modifies mechanical energy and transmits it in a more useful form.

2. What is machine tool?

Machine is a mechanical device which having a provisions for holding the work and tool with on a facilities rotation of work and different feed of the tool.

3. Define the term turning?

Turning is a machining process to bring the raw material to the required shape and size by metal removal. This is done by feeding a single point cutting tool against the direction of rotation of the work.

The machine tool on which turning is carried out is known as lathe.

4. What are the different types of lathes?

Centre lathe, bench lathe, capstan lathe, combination lathe, turret lathe, CNC lathes.

5. What are the differences between the center lathe and Capstan Lathe?

Centre lathe - It is a manually operated lathe, It has only one tool post tool changing time is more, It has tail stock, Only one tool can be fitted in the tail stock, Number of speeds is less, Tool changing time is more, The machine should be stopped for changing tool, It is not suitable for mass production, The tool is centered manually after changing the tool,

Capstan/turret lathe - It is a semi automatic lathe, Front and rear tool posts are available. Tool changing time is less, It has turret head instead of tail stock, Six different tools can be fitted in the turret head. Number of speeds is more, Tool changing time is less, Tool can be changed without stopping the machine, It is suitable for mass production , The tool is centered automatically,

6. How the center lathe can be specified?

- ❖ The maximum diameter of a work that can be held
- ❖ The length of the bed
- ❖ Distance of the between centers

- ❖ The range of threads can be cut

- Capacity of the lathe
- Range of spindle speed

7. What are the functions of lead screw and feed rod?

lead screw – for thread cutting purpose.

feed rod – to provide automatic feeding either for facing or turning.

8. What are the different methods of taper turning?

1) Compound slide method
2) Tailstock offset method
3) Form tool method
4) Taper turning attachment method

9. What is meant by eccentric turning?

When different diameters are turned on different axis, it is said to be eccentric turning.

10. What is the difference between L.H. thread cutting R.H. thread cutting?

a) A right hand bolt thread screws into the nut when it is rotated clockwise.
b) A right hand bolt thread screws into the nut when it is rotated anticlockwise.

11. Why the knurling operations are necessary for the given models in m/c shop?

a) A good grip and make for positive handling
b) Good appearance
c) For raising the diameter to a small range for assembly to get a desired fit.

12. How the change gears calculations can be done during thread cutting operation for British and Metric pitches?

Standard general formula is,

The gear ratio = driver/driven = pitch of the work/pitch of the lead screw

Gear ratio for cutting metric thread on British lathe

Gear ratio = driver/driven = pitch to be cut on the job/pitch of lead screw

= pitch to be cut in mm x TPI on lead screw x 5/127

Gear ratio for cutting British thread on metric lathe

Gear ratio = driver/driven = pitch to be cut on the job/pitch of lead screw in mm

= 127/5 x pitch of work (TPI)/pitch of lead screw in mm

Note: a translating gear of 127 teeth is provided for cutting metric and British threads on different lead of lead screw i.e. TPI or mm.

13. What are the differences between 3-jaw chuck and 4-jaw chuck?

3 – Jaw chuck

Only cylindrical or hexagonal work center, internal and external jaws are available, setting of work is easy, less gripping power, work pieces can't be set for eccentric turning, concentric circles are not provided on the face.

4 – Jaw chuck.

A wide range of regular and irregular shaped jobs can be held, jaws are reversible for external and internal holdings, setting of work is difficult, more gripping power, work pieces can be set for eccentric turning, concentric circles are provided.

14. What are the differences between lathe accessories and lathe attachments? Give examples.

a) The *lathe accessories* are machined, independent units supplied with the lathe, which are essential for the full utilization of the lathe,

   Example,

   1) *Work holding accessories* – 4 – jaw chuck, 3 – jaw chuck, face plates, lathe mandrels.
   2) *Work supporting accessories* – catch plate, driving plate, lathe centers, lathe carriers, fixed and travelling steady rests.

b) *Attachment* is an optional extra attachments to produce tapers, contours, thread forming, grinding, etc…

   Example,

1) Taper turning attachment
2) Forming attachment
3) Cylindrical, grinding, thread, grinding attachment

15. What is meant by single point cutting tool?

Single point cutting tools have one cutting edge which performs the cutting action. Most of the lathe cutting tools are single point cutting tools.

16. What is meant by multi point cutting tool? Give examples.

These tools have more than one cutting edge and they remove metal from the work piece simultaneously by the action of all the cutting edges,

Ex. Files, hacksaw blade, twist drills, reamers, milling cutters, hand taps, and spilt dies, grinding wheels.

17. What are the properties of cutting tool material?

The most important basic properties of only cutting tool is,

- Cold hardness
- Red hardness
- Toughness

18. What is meant by H.S.S. tool? What are the elements present in that?

HSS (High Speed Steel) is an alloy of high carbon steel with an alloying elements like Tungsten 18%, Chromium 4% and Vanadium of 1%.

19. What is meant by carbide tipped tool?

These tools are made of two different metals, the cutting portions of these tools are tungsten carbide which are brazed to ordinary metal blank which are tough (low cost).

20. Define cutting speed. Feed and depth of cut?

a) *Cutting speed* – "The speed at which the cutting edge passes over material" which is expressed in meters per minute is called the cutting speed.

V = ΠDN/1000 meter/min. (OR) V = ΠDN/12 feet/min.

Where – V = cutting speed in meters/min

Π = 3.14

D = diameter of work piece in mm

N = rpm

b) *Feed* – The feed of the tool is the distance it moves along the work for each revolution of the work. and it is expressed in mm/revolution.

c) *Depth of cut* – It is the advancement of the tool at the beginning of the feed which is perpendicular to the type of feed.

21. What is the spindle speed during thread cutting operation?

Set the spindle speed to about $1/4^{th}$ of the normal turning speed.

22. What is difference between orthogonal cutting and oblique cutting?

Orthogonal cutting – Is a process of cutting operation where only two forces i.e. tangential and axial forces are acting on the tool while turning

Oblique cutting - Is a process of cutting operation where three forces i.e. Tangential, axial and radial forces are acting on the cutting tool while turning.

23. Why steady rest and follower rest are used?

A steady rest and follower rest are the lathe accessories used to give extra support for a long slender work piece in addition to the centre support during turning.

24. Why the mandrels are used?

Lathe mandrels are devices used to hold the job for machining on lathes. They are mainly used for machining outside diameters with reference to bores which have been duly finished by either reaming or boring on a lathe.

25. What are the measuring (limit) gauges used while doing/machining components on lathe?

Internal features check	*External features check*
Cylindrical plug gauge	Plain ring gauge
Taper plug gauge	Taper ring gauge
Screw threaded plug gauge	Screw pitch gauge
Fillet gauge	Radius gauge

26. What is the formula for calculating the machining time on lathe?

Time to turn = length of cut x no. of cuts / feed x r p m minutes

(OR)

T = L x n/ f xN min.

27. Which are the factors governing the cutting speed?

- Finish required
- Depth of cut
- Tool geometry
- Properties of cutting tool material
- Properties of work material
- Type of cutting fluid used
- Rigidity of the machine tool

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