NEHRU COLLEGE OF ENGINEERING AND RESEARCH CENTRE

(Accredited by NAAC, Approved by AICTE New Delhi, Affiliated to APJKTU)

Pampady, Thiruvilwamala(PO), Thrissur(DT), Kerala 680 588

DEPARTMENT OF MECHATRONICS

LAB WORK BOOK

MR 332 MANUFACTURING ENGINEERING LABORATORY

VISION

To mould true citizens who are millennium leaders and catalysts of change through excellence in education.

MISSION

NCERC is committed to transform itself into a center of excellence in Learning and Research in Engineering and Frontier Technology and to impart quality education to mould technically competent citizens with moral integrity, social commitment and ethical values.

We intend to facilitate our students to assimilate the latest technological know-how and to imbibe discipline, culture and spiritually, and to mould them in to technological giants, dedicated research scientists and intellectual leaders of the country who can spread the beams of light and happiness among the poor and the underprivileged.

ABOUT DEPARTMENT

- Established in: 2013
- Course offered: B.Tech Mechatronics Engineering
- Approved by AICTE New Delhi and Accredited by NAAC
- Affiliated to the University of Dr. A P J Abdul Kalam Technological University.

DEPARTMENT VISION

To develop professionally ethical and socially responsible Mechatronics engineers to serve the humanity through quality professional education.

DEPARTMENT MISSION

MD 1: The department is committed to impart the right blend of knowledge and quality education to create professionally ethical and socially responsible graduates.

MD 2: The department is committed to impart the awareness to meet the current challenges in technology.

MD 3: Establish state-of-the-art laboratories to promote practical knowledge of mechatronics to meet the needs of the society.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: Graduates shall have the ability to work in multidisciplinary environment with good professional and commitment.

PEO2: Graduates shall have the ability to solve the complex engineering problems by applying electrical, mechanical, electronics and computer knowledge and engage in lifelong learning in their profession.

PEO3: Graduates shall have the ability to lead and contribute in a team with entrepreneur skills, professional, social and ethical responsibilities.

PEO4: Graduates shall have ability to acquire scientific and engineering fundamentals necessary for higher studies and research.

PROGRAM OUTCOMES (PO'S)

Engineering Graduates will be able to:

PO 1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2. 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.

PO 3. 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.

PO 4. 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.

PO 5. 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.

PO 6. 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.

PO 7. 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.

PO 8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10. 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.

PO 11. 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.

PO 12. 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.

PROGRAM SPECIFIC OUTCOMES (PSO'S)

PSO 1: Design and develop Mechatronics systems to solve the complex engineering problem by integrating electronics, mechanical and control systems.

PSO 2: Apply the engineering knowledge to conduct investigations of complex engineering problem related to instrumentation, control, automation, robotics and provide solutions.

COURSE OUTCOME

C318.1	Acquire the basic knowledge in machining
C318.2	Examine shaper machine tool and milling machine
C318.3	Experimentally conduct taper turning, external and internal thread cutting, eccentric turning using lathe
C318.4	Demonstrate machining hexagon & square from round rod using milling and shaper machine
C318.5	Experimentally conduct spur gear and helical gear cutting in milling machine
C318.6	Demonstrate plain surface and cylindrical grinding and counter milling and familiarize CNC part programming

CO VS PO'S AND PSO'S MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C318.1	3	3	3	3	3	-	-	-	3	-	-	-	2	2
C318.2	3	2	3	2	1	-	-	-	3	-	-	2	2	2
C318.3	3	2	3	2	3	-	-	-	3	-	-	3	2	2
C318.4	3	-	-	-	-	-	-	-	3	-	-	2	2	2
C318.5	3	-	-	-	-	-	-	-	3	-	-	-	2	2
C318.6	3	2	3	3	3	-	-	-	3	-	-	3	2	2
ATTAINMENT	3.00	2.25	3.00	2.50	2.50	0.00	0.00	0.00	3.00	0.00	0.00	2.50	2.00	2.00

Note: H-Highly correlated=3, M-Medium correlated=2, L-Less correlated=1

PREPARATION FOR THE LABORATORY SESSION

GENERAL INSTRUCTIONS TO STUDENTS

1. Read carefully and understand the description of the experiment in the lab manual. You may go to the lab at an earlier date to look at the experimental facility and understand it better. Consult the appropriate references to be completely familiar with the concepts and hardware.

2. Make sure that your observation for previous week experiment is evaluated by the faculty member and your have transferred all the contents to your record before entering to the lab/workshop.

3. At the beginning of the class, if the faculty or the instructor finds that a student is not adequately prepared, they will be marked as absent and not be allowed to perform the experiment.

4. Bring necessary material needed (writing materials, graphs, calculators, etc.) to perform the required preliminary analysis. It is a good idea to do sample calculations and as much of the analysis as possible during the session. Faculty help will be available. Errors in the procedure may thus be easily detected and rectified.

5. Please actively participate in class and don’t hesitate to ask questions. Please utilize the teaching assistants fully. To encourage you to be prepared and to read the lab manual before coming to the laboratory, unannounced questions may be asked at any time during the lab.

6. Carelessness in personal conduct or in handling equipment may result in serious injury to the individual or the equipment. Do not run near moving machinery/equipment’s. Always be on the alert for strange sounds. Guard against entangling clothes in moving parts of machinery.

7. Students must follow the proper dress code inside the laboratory. To protect clothing from dirt, wear a lab coat. Long hair should be tied back. Shoes covering the whole foot will have to be worn.

8. In performing the experiments, please proceed carefully to minimize any water spills, especially on the electric circuits and wire.

9. Maintain silence, order and discipline inside the lab. Don't use cell phones inside the laboratory.

10. Any injury no matter how small must be reported to the instructor immediately.

11. Check with faculty members one week before the experiment to make sure that you have the handout for that experiment and all the apparatus.

AFTER THE LABORATORY SESSION

1. Clean up your work area.

2. Check with the technician before you leave.

3. Make sure you understand what kind of report is to be prepared and due submission of record is next lab class.

4. Do sample calculations and some preliminary work to verify that the experiment was successful

MAKE-UPS AND LATE WORK

Students must participate in all laboratory exercises as scheduled. They must obtain permissionfrom the faculty member for absence, which would be granted only under justifiable circumstances. In such an event, a student must make arrangements for a make-up laboratory, which will be scheduled when the time is available after completing one cycle. Late submission will be awarded less mark for record and internals and zero in worst cases.

LABORATORY POLICIES

1. Food, beverages & mobile phones are not allowed in the laboratory at any time.

2. Do not sit or place anything on instrument benches.

3. Organizing laboratory experiments requires the help of laboratory technicians and staff. Be punctual.

SYLLABUS

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR332	**Manufacturing Engineering Lab**	0-0-3-1	2016

Prerequisite : ME220 Manufacturing technology

Course Objectives

- To demonstrate specific machine tools
- To familiarise with the different manufacturing operations

LIST OF EXPERIMENTS (Any 6 Exercises)

1. Centre Lathe- 2 Exercises (4 sections)
2. Drilling Machine-1 Exercises (2 sections)
3. Milling Machine-2 Exercises (4 sections)
4. Shaping Machine-1 Exercises (2 sections)
5. Slotting Machine-1 Exercises (2 sections)
6. Grinding Machine-1 Exercises (2 sections)
7. CNC Processes Machine-1 Exercises (2 sections)

Expected outcome.

On completion of the course the student will be able to

i. Operate specific machine tools and perform simple machining operations.
ii. Develop simple CNC part programs

Text Book:

1. Sharma, P.C., *A textbook of Production Technology – Vol I and II*, S. Chand & Company Ltd., NewDelhi, 1996.
2. Rao, P.N., *Manufacturing Technology, Vol I & II*, Tata McGraw Hill Publishing Co., New Delhi, 1998.

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FINAL VERIFICATION BY THE FACULTY
TOTAL MARKS:

INTERNAL EXAMINER **EXTERNAL EXAMINER**

1. STUDY ON BASIC MACHINING

AIM

To study the construction details and working principle of basic machining.

INTRODUCTION

Machining is the process of converting the given work piece into the required shape and size with help of a machine tool. The most widely used machine tool is lathe. In simple words machining is the process of removing certain material from the work piece.

LATHE

Lathe is the machine tool which is used to perform several operations on the work piece. Lathe is useful in making several parts which is further assembled to make new machine. Hence lathe is known as "mother of machines".

BASIC WORKING PRINCIPLE OF LATHE

In lathe, the work piece is held in the chuck, a work holding device. The cutting tool is mounted in the tool post. The chuck is rotated by means of power. When the chuck rotates, the work piece also rotates. The tool is moved against the rotating work piece by giving small amount of depth of cut. The material is removed in the form of chips. Continuous feed and depth of cut is given until the required dimensions are obtained in the work piece.

TYPES OF LATHE MACHINES

There are different types of lathe machines, they are

1. Centre lathe
2. Tool room lathe
3. Bench lathe
4. Capstan lathe
5. Turret lathe
6. Automatic lathe

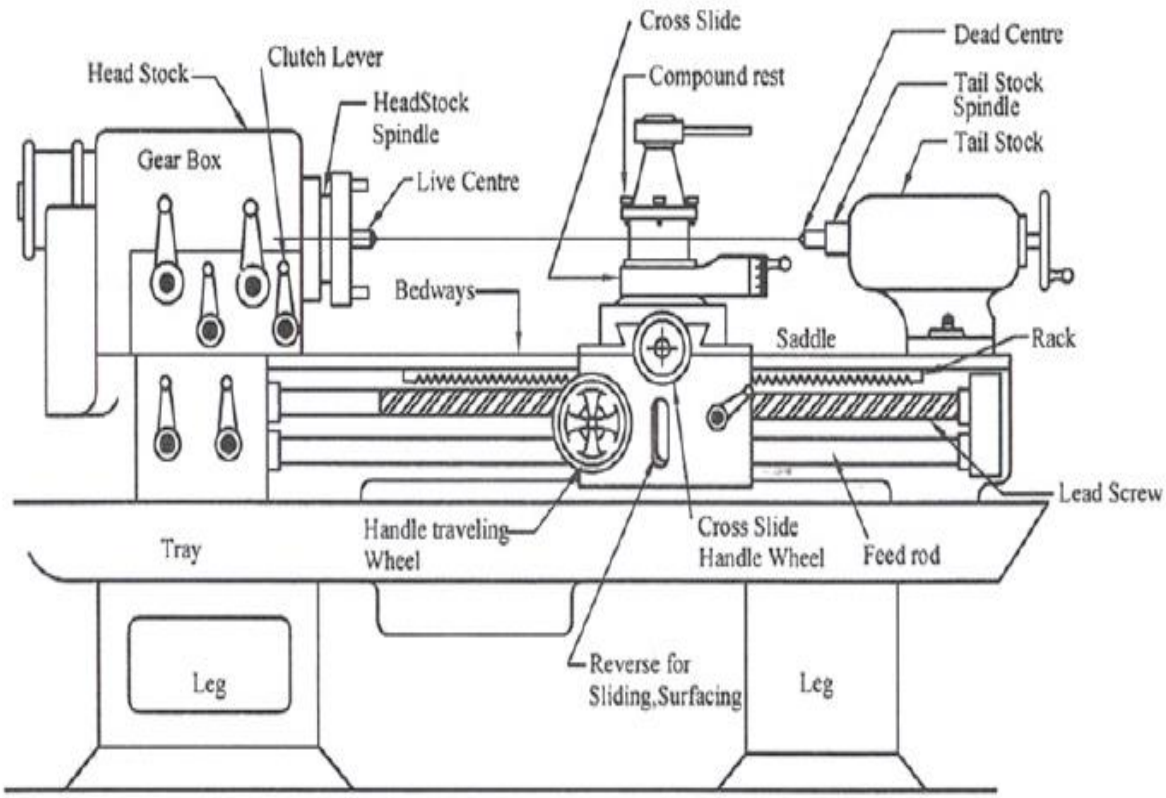


Fig. 1 The centre Lathe

DESCRIPTION OF LATHE

Lathe is a machine which has several parts in it. They are

1. Bed

It is the base of the machine. On its left side, the head stock is mounted and on its right it has movable casting known as tailstock. Its legs have holes to bolt down on the ground.

2. Head stock

It consists of spindles, gears and speed changing levers. It is used to transmit the motion to the job. It has two types one is the headstock driven by belt and the other one is the gear driven.

3. Carriage

Carriage is used to carry a tool to bring in contact with the rotating work piece or to with draw from such a contact. It operates on bed ways between the headstock and tail stock.

4. Saddle

It is an ‘H’ shaped part fitted on the lathe bed. There is a hand wheel to move it on the bed way. Cross slide, compound rest, tool post is fitted on this saddle.

a) Cross slide

It is on the upper slide of saddle in the form of dove tail. A hand wheel is provided to drive the cross slide. It permits the cross wise movement of the tool (i.e.) movement of tool towards or away from the operator

b) Compound rest

It is fitted over the cross slide on a turn table. It permits both parallel and angular movements to cutting tool.

c) Tool post

It is fitted on the top most part of the compound rest. Tool is mounted on this tool post. Cutting tool is fixed in it with the help of screws.

5. Apron

It is the hanging part in front of the carriage. It accommodates the mechanism of hand and power feed to the cutting tool for carrying out different operations.

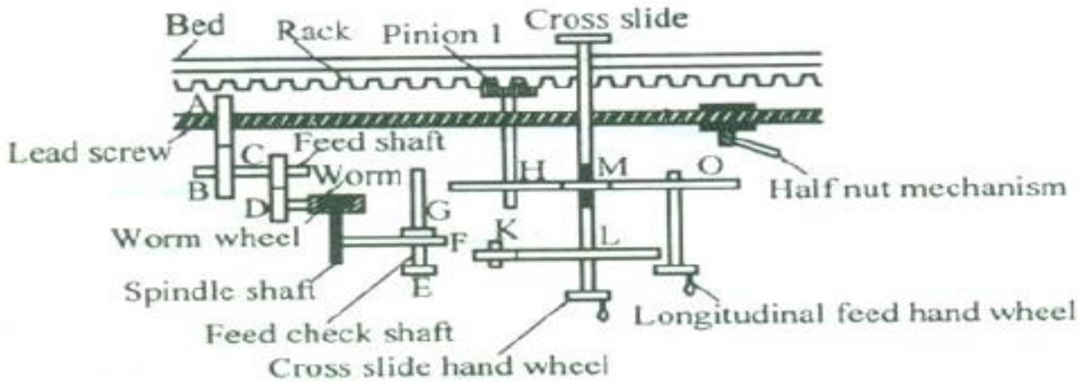


Fig. 2 Apron

6. Lead screw

It is a long screw with ACME threads. It is used for transmitting power for automatic feed or feed for thread cutting operation.

7. Tail stock

It is located at the right end of the lathe bed and it cn be positioned anywhere in the bed. It is used for supporting lengthy jobs and also carries tool to carry out operations such as tapping, drilling, reaming.

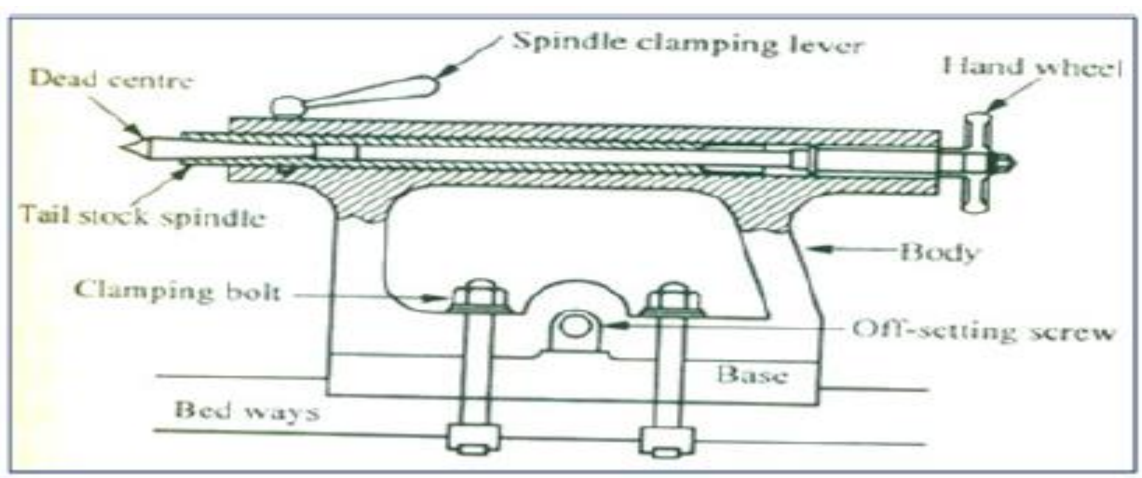


Fig. 3 Tailstock

WORK HOLDING DEVICES

1. Lathe centers

They are used to support work. It has two categories of centers. Live center is one which is fitted in the headstock spindle. Dead is another one which is fitted in the tail stock.

2. Chuck

It is a device used to hold a job. It is easily fitted on the thread cut on the end of head stock spindle. Various types of chuck are a) Two jaw chuck b) three jaw chuck c) four jaw chuck d) collet chuck

e) Magnetic chuck

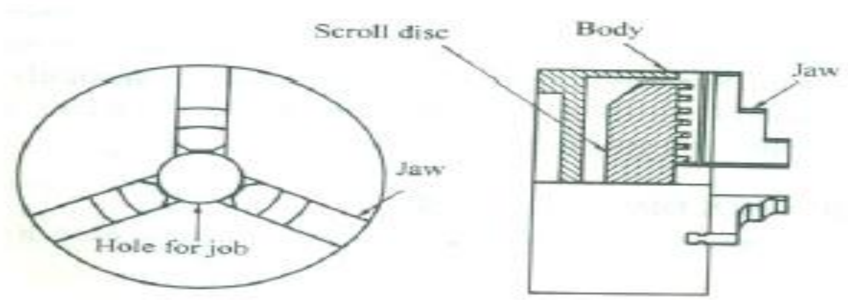


Fig. 4 Three Jaw Universal self-centering chuck

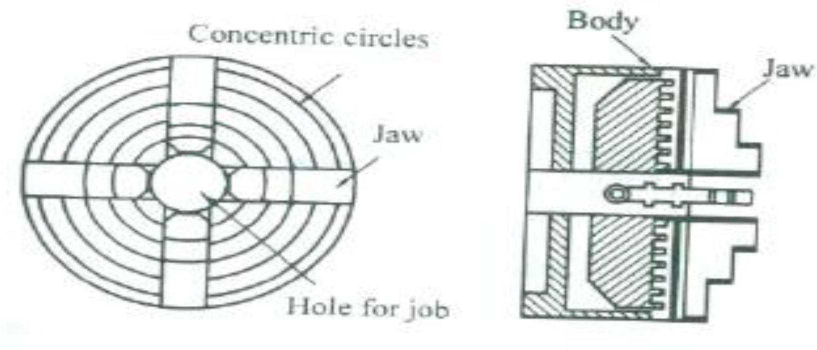


Fig. 5 Four Jaw Independent chuck

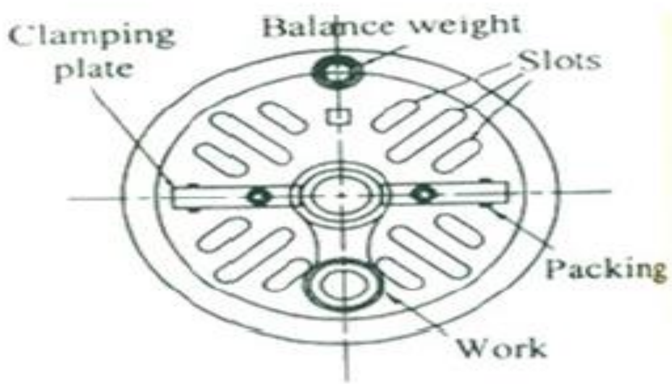


Fig. 6 Face Plate

3. Face plate

4. Catch plate

5. Lathe carriers or dog's

6. Steady rest

7. Mandrel

8. Follower rest

CUTTING TOOLS USED

For making a finished job on lathe machine, various types of cutting tools are used. One of them is single point cutting tool which is used to perform several operations on the work piece. Various types of cutting tools are

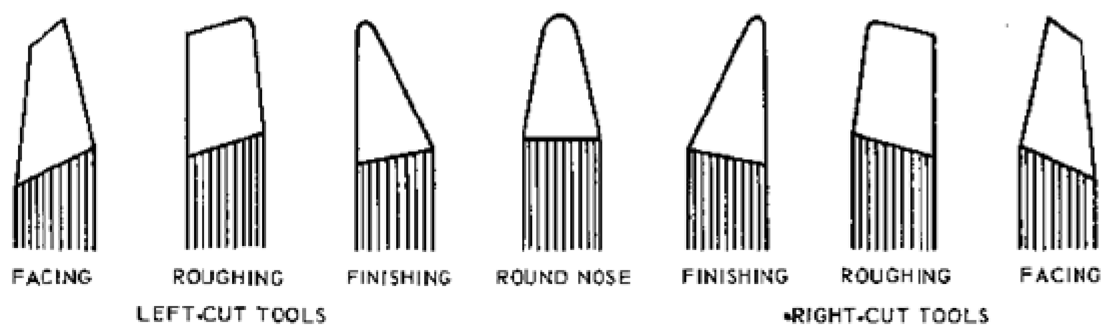


Fig. 7 Cutting Tools

1. Facing Tool

It is used for facing the longitudinal ends of the job. Its shape is like a knife.

2. Rough Turning Tool

It is used to remove excess material from the work piece in quick time. It can be used to give large depth of cut and work at coarse feed.

3. Finishing Tool

It is used for getting smooth finish on the work piece. Its point is a little more round.

4. Radius Tool

Jobs which need round cutting are done with this tool. Its type is a) Convex radius tool b) concave radius tool

5. Parting Tools

It is used to cut the jobs into two parts. It is also used for grooving.

6. Form Turning Tool

It is used for jobs which require both convex and concave turning.

7. Thread Cutting Tool

It is used for making internal or external threads on the work piece. The tool nose is designed with a definite profile for taking threads.

8. Drill Tool

It is used for making holes of various diameters on the job. Drill bit of various sizes of diameter are available.

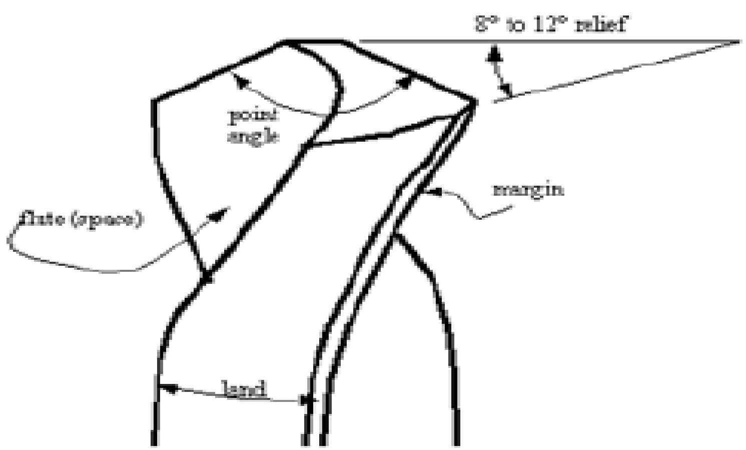


Fig. 8 Drill Tool

9. Boring Tool

It used for enlarging the drill hole.

10. Knurling Tool

Drawing slanting or square projecting lines on the surface of a job is known as knurling. It is used for making better grip on the surface of a job.

TOOL MATERIALS

1. The single point cutting tools are made of high speed steel. (H. S. S)

2. The main alloying elements in 18 – 4 – 1 HSS tools are 18 % tungsten, 4% chromium and 1 % Vanadium. 5 to 10 % cobalt is also added to improve the heat resisting properties of the tool.

3. General purpose hand cutting tools are usually made from carbon steel or tool steel.

4. Carbide tipped tools fixed in tool holders, are mostly used in production shops.

NOMENCLATURE OF SINGLE POINT CUTTING TOOL

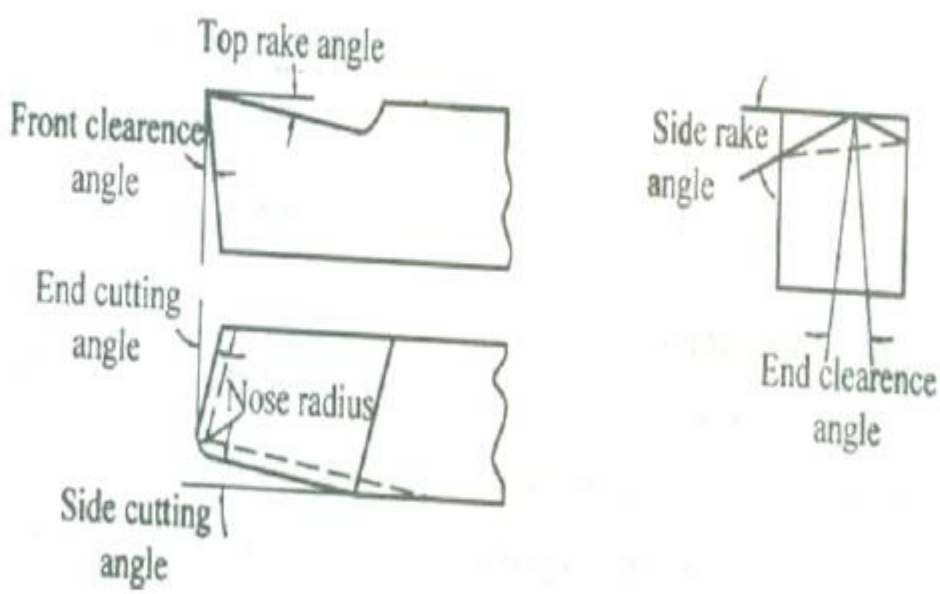


Fig. 9 Nomenclature of Single Point Cutting Tool

CUTTING TOOL ANGLES

1) Top rake angle (back rake angle) a. If the slope is given to the face or surface of the tool and if this slope is along the tools length then it is called top rake angle. It is usually 15° to 20°.

2) Side rake angle

a. If the slope is given to the face or top of the tool along the tools width then it is called side rake angle. It lies between 6° and 15°.

3) Clearance angle (relief angle)

a. Types:

1. Side clearance angle

2. End clearance angle.

b. They are provided to keep surface of the tool clear of the work piece.

4) Cutting edge angle (Types)

1. Side cutting edge angle – (generally 15°) it is an angle, the side cutting edge makes with the axis of the tool.

2. End cutting edge angle – (from 7° to 15°) it is an angle, the end cutting edge makes with the width of the tool.

5) Lip angle (cutting angle)

a. It is the angle between the face and the end surface of the tool.

6) Nose angle

b. It is the angle between the side cutting edge and end cutting edge.

LATHE OPERATIONS

1. Facing

• It is done for getting fine finish (good surface finish) on the face of the job.

• Facing tool is set at an angle to the work piece.

• The tool is fed from the Centre of work piece towards the outer surface against the rotating work piece.

• Depth of cut is low for the facing operation.

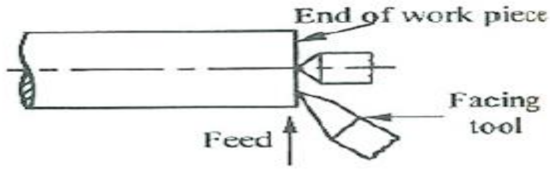


Fig. 10 Facing

2. Plain Turning

• It is done for reducing the diameter of the work piece.

• A cutting tool with 70° setting angle is used for roughing operation.

• More feed is given for rough turning while less feed is given for finishing.

• Work piece is held in chuck and tool is set to center height of the work piece.

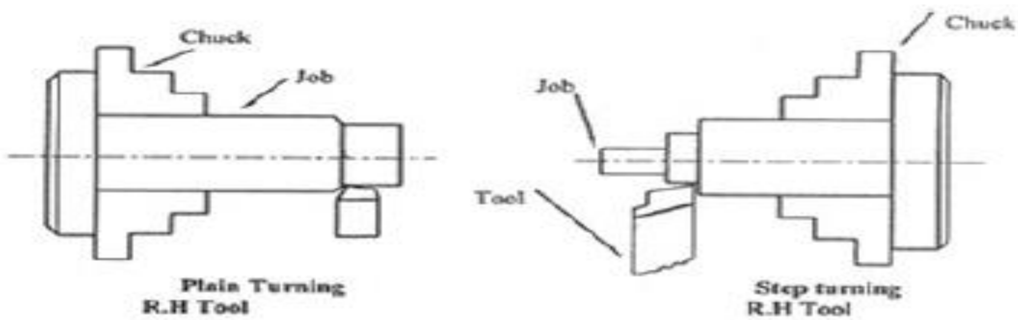


Fig. 11 Plain Turning

The angle is determined by using the formula $\tan \alpha = \frac{D - d}{2l}$

Where,	D	–	large Diameter
	d	–	Small diameter
	l	–	Length of taper

5. Knurling

• It is process of making serrations on the work piece.

• Knurling tools of different shape and size are used to make grip on the work piece. It has two hardened steel rollers.

• The tool is held in tool post and pressed against the rotating work piece.

• Work piece is rotated at lower speed and small amount of feed is given.

6. Drilling

• It is a process of making a hole on the work piece

• Job is held in chuck while the drill is held in the tail stock sleeve.

• Feed is given by rotating the hand wheel in the tail stock which pushes the tailstock sleeve.

CUTTING SPEED

• It is the peripheral speed of the work past the cutting tool.

• It is the speed at which metal is removed by the tool from the work piece.

• It is expressed in meter / minute.

$$\text{Cutting speed} = \frac{\pi \times \text{diameter} \times \text{R.P.M}}{1000}$$

$$= \frac{\pi D N}{1000} \, in \ m/min$$

Where, D – Diameter in mm

N – Spindle speed in rpm

FEED

• It is defined as the rate of tool travel across a surface cutting it.

• It is the distance of the tool advances for each revolution of the work piece.

• It is expressed in mm/revolution.

DEPTH OF CUT

• It is the perpendicular distance measured from the machined surface to the uncut surface of work. It is expressed in mm.

$$\text{depth of cut} = \frac{d_1 - d_2}{2}$$

Where, d_1 = diameter of work before machining

d_2 = diameter of work after machining.

RESULT

Thus the basic machining was studied.

2. STUDY OF SHAPER

AIM

To study the construction details and working principle of a shaper machine tool.

CONSTRUCTION AND WORKING PRINCIPLE

• Shaper is a reciprocating type of machine tool. It is used for machining the surfaces. The surface may be horizontal and vertical indeed. The shaper has the main parts such as base, table, column, cross-rail, ram and tool head. The base bolted to the floor, it is made of C.I and absorbs entire load.

• The column is box type in which return mechanism of ram is provided. At the top of the column, there are two mechanical I guide ways. The ram reciprocating on their guide ways in the front vertical guide ways in which the table the rectangular hallow block. It slides rail is mounted guide ways of iron-rail. It has machine surface on the top and slides. These surfaces have T slots for clamping work. The rail carries the tool head in which the tool head is in vertical position. The ram reciprocation on the guide ways on top of column.

• The work is held on the table by using correct work holding device. A single tool is in vertical position of the cutting stroke (forward bias) the feed is given at the end of each cutting stroke during the return stroke, no metal is cut. The cutting stroke takes place at slow speed and the return stroke takes place at a faster speed. The faster feed rate is obtained using quick return.

• By adjusting the work piece position as tool position step cutting, v-cutting, etc…., is machined in shaping machine.

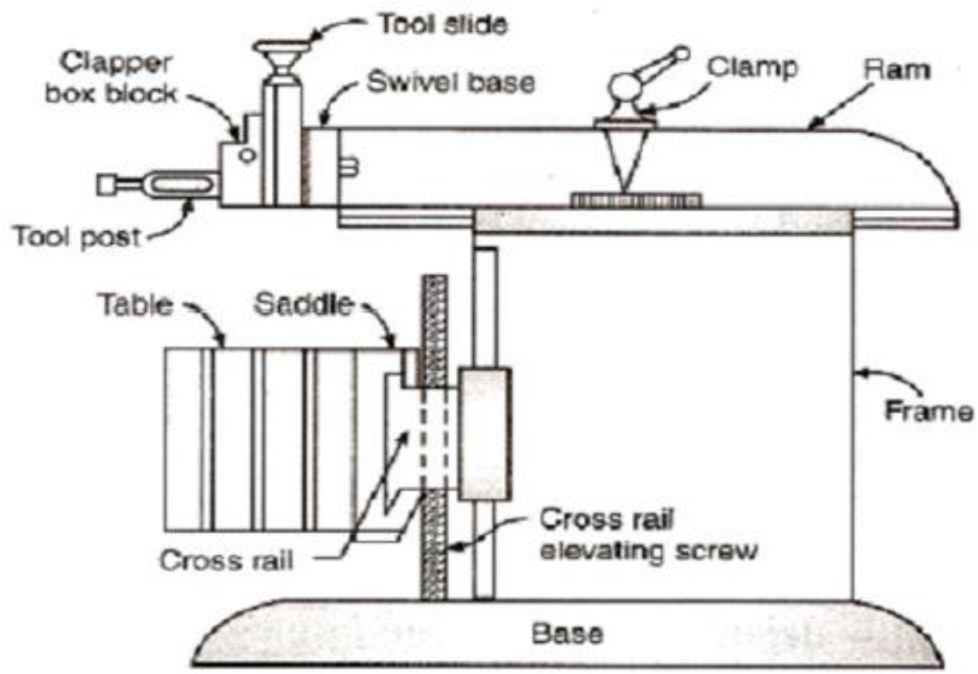


Fig. 13 The Shaper

RESULT

Thus the construction details and the working principle of the standard shaper are studied.

3. STUDY OF MILLING MACHINE

AIM

To study the construction details and working principle of milling machine.

CONSTRUCTION AND WORKING PRINCIPLE

• A milling machine is a machine tool that renioues metal from the work which is fed against a retailing multipoint cutter. The cutter rotates at a high speed and because of the multiple cutting edges it removes metal at a very fast rate.

• The base of the machine is grey iron casting, actually machined on its top and bottom surface. It carries the column at its one end. The column is the main support structure mounted vertically on the base. The column is box shaped, heavily ribbed inside and bases all the driving mechanism for the spindle and table feed. The front vertical face of column has details guide ways for supporting the knee. The top of the column is finished to hold on over arm that extends outward at front machine.

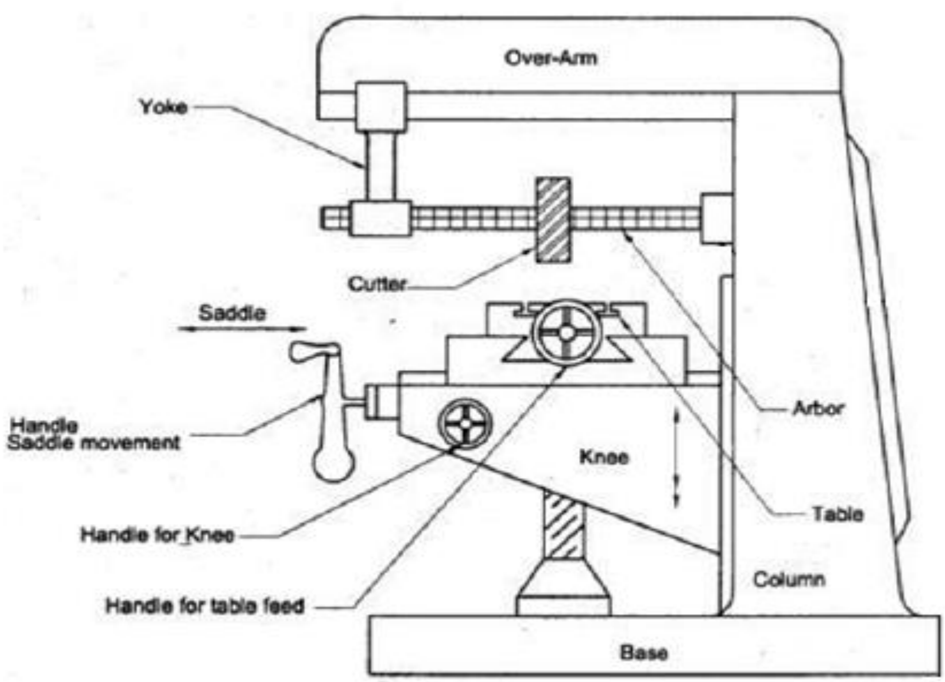


Fig. 14 The Milling Machine

The knee is grid grey iron casting that slides up and down on the vertical away of column face. The knee gives the feed mechanism of table and different controls operate is saddle placed on top surfaces of knee which slides on guide ways perpendicular to column face. The feed movement of saddle is obtained by hand or by power.

• The overhanging arm is mounted on the top column the arm is adjusted so that bearing support may be provided of cutter. The spindle has the mouse taps at its front face in which various cutting tools may be inserted. The taper chance for proper alignment with the machine spindle handling taper holes at their none.

RESULT

Thus the construction and working principle of milling machine is studied.

4. TAPER TURNING OPERATION BY USING A LATHE

AIM

To machine a work piece by facing, plain turning and taper turning operation using a lathe.

MATERIALS REQUIRED

Mild steel polished round rod - f 25 X 100 mm

TOOLS REQUIRED

_ Lathe machine

_ Steel Rule

_ Cutting tool

_ Vernier Caliper

_ Outside Caliper

_ Spanner

FORMULA

1) The taper angle is calculated using the following formula:

$$\text{Taper angle } (\propto) = \tan^{-1}\left(\frac{D-d}{2l}\right)$$

Where

D = large diameter of taper in mm

d = small diameter of taper in mm

l = length of tapered part in mm

$\propto$ = angle of taper

2) Time taken for taper turning :

$$T = \frac{\text{Length of the cut}}{[\text{Feed x rpm}]} \times \text{Number of cuts}$$

Where,

Depth of the cut should not exceed 4mm

Cutting speed, S = 75 mm/rev

Maximum feed, f = 0.05mm/rev

Rpm, N = [1000×S/ π × D]

PROCEDURE

1. The given work piece is held firmly in a lathe chuck.

2. The cutting tool is set in a tool post such that the point of the Cutting tool coincides with the lathe axis.

3. The machine is switched on to revolve the work piece at the selected speed.

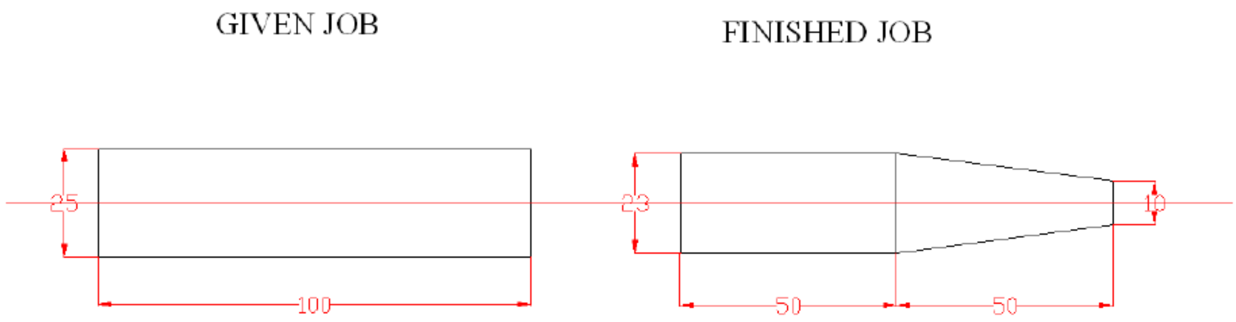
4. By giving Cross feed and longitudinal feed to the cutting tool, the facing and turning operations are done respectively.

5. The compound rest is swiveled for the calculated taper angle.

6. By giving angular feed to the cutting tool through the compound slide the taper turning operation is done.

7. The machine is switched off.

8. The work piece is removed from the chuck and all the dimensions are measured and checked.



ALL THE DIMENSIONS ARE IN'mm'

CALCULATION

1) Taper angle calculation:

$$\text{Taper angle } (\propto) = \tan^{-1}\left(\frac{D-d}{2l}\right)$$

$$= \tan^{-1}(23-10/2X50)$$

$$\propto = 7.4^{\circ}$$

(2) → HG = HE X Sin θ

= 45 X 0.14

HG = 6.4 mm

Estimation of machining time:

$$T = \frac{\text{Length of the cut}}{[\text{Feed x rpm}]} \times \text{Number of cuts} \qquad \text{---------------- (1)}$$

Let,

ED = Length of the cut required for taper turning

$ED = \sqrt{DH^2 + HE^2}$

$ED = \sqrt{6.5^2 + 45^2}$

$ED = \sqrt{42.25 + 2025}$

ED = 45.46 mm

Number of cut required:

$$= \frac{HG}{\text{Depth of cut}}$$

From Δ GHE,

$$\text{Sin}\ \theta = \frac{HG}{HE}$$

$HG = HE \times \text{Sin}\ \theta$ ------------------ (2)

From Δ DHE ,

$$\text{Sin}\ \theta = \frac{HG}{HE}$$

$$\text{Sin}\ \theta = \frac{6.5}{45.46}$$

= **0.14**

No. of cuts = 6.4/4

= 1.6

≈ 2 cuts

Speed, $N = (1000 \times S / \pi D)$

$= (1000 \times 75 / \pi \times 23)$

N = 1038.5 rpm

(2) → T = [(45.46 /0.05 X 1038.5) X 2]

T=1.75 min.

ASSUME:

- ✓ Depth cut should not exceed 1mm
- ✓ Cutting speed = 75 mm/min
- ✓ Max. feed = 0.05 mm/rev

RESULT

The given work piece as shown in fig. is subjected to facing, plain turning and taper turning operation to become a finished work piece as shown in fig.

5. EXTERNAL THREAD CUTTING BY USING A LATHE

AIM

To machine a work piece by facing, plain turning and external thread cutting operations using a lathe.

MATERIALS REQUIRED

• Mild steel polished round rod - f 25 X 100 mm

TOOLS REQUIRED

_ Outside Caliper

_ Turning tool .

_ Vernier Caliper

_ External V – thread cutting tool

FORMULA

1) ***Time taken for external threads:***

$$T = \frac{\text{Length of the cut}}{[\text{pitch x rpm}]} \times \text{Number of cuts}$$

2) ***Number of cuts***

$$T = \frac{25}{\text{Threads per 'cm'}} \text{ for external threads}$$

PROCEDURE

1. The given work piece is held firmly in a lathe chuck.

2. The cutting tool is set in a tool post such that the point of the Cutting tool coincides with the lathe axis.

3. The machine is switched on to revolve the work piece at the selected speed.

4. By giving Cross feed and longitudinal feed to the cutting tool, the facing and turning operations are done respectively.

5. The speed of the work piece is reduced.

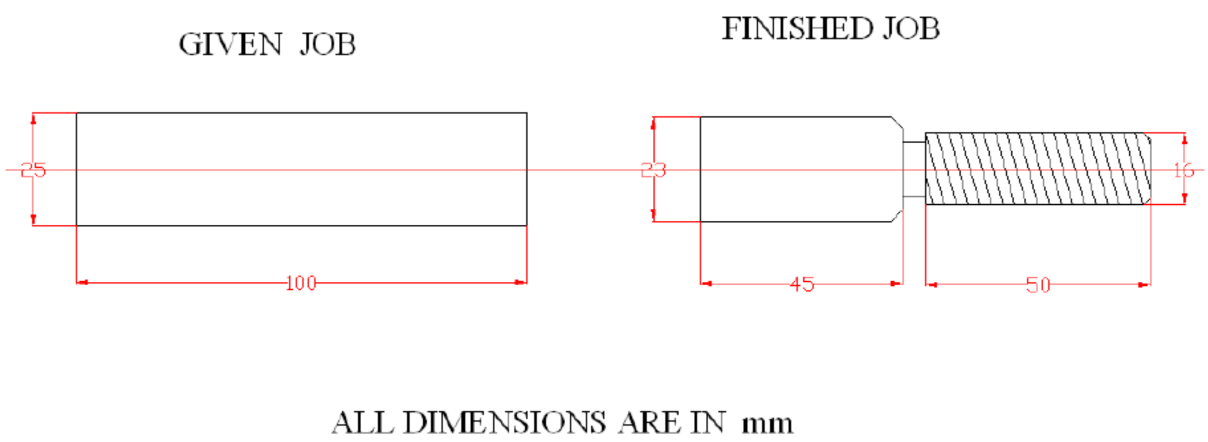
6. The machine is switched off and the change gears of calculated teeth (as per calculation) are connected.

7. Again the machine is switched on.

8. The external thread cutting operation is done using external thread cutting tool by engaging thread cutting mechanism.

9. The machine is switched off.

10. The work piece is removed from the chuck and all the dimensions are measured and checked.



CALCULATION

The number of teeth on change gears is calculated using the following formula:

Driver teeth/ Driven teeth = Pitch of the work / pitch of the lead screw

RESULT

The given work piece as shown in fig. is subjected to facing, plain turning, knurling and external thread cutting operations to become a finished work piece as shown in fig.

6. KNURLING OPERATION BY USING A LATHE

AIM

To machine a work piece by facing, plain turning, knurling operations using a lathe.

MATERIALS REQUIRED

• Mild steel polished round rod - f 25 X 100 mm

TOOLS REQUIRED

_ Lathe machine

_ Turning tool

_ Knurling tool

_ Outside Caliper

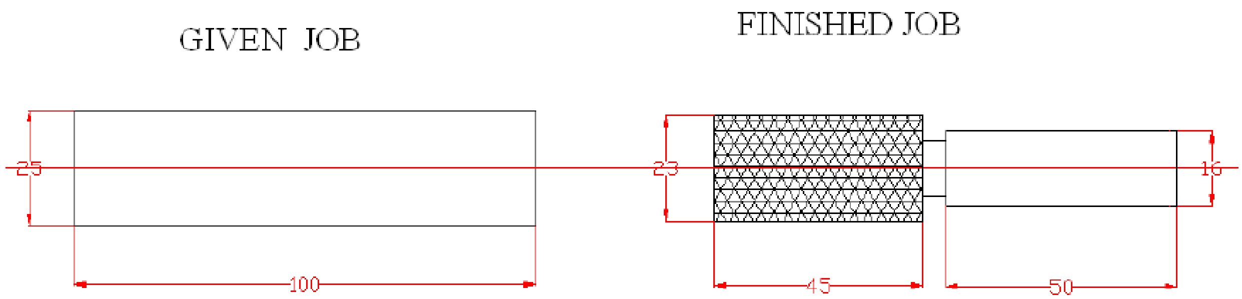
_ Steel Rule

_ Vernier Caliper

FORMULA

Time taken for knurling:

$$T = \frac{\text{Length of the cut}}{[\text{Feed x rpm}]}$$



ALL DIMENSIONS ARE IN mm

PROCEDURE

1. The given work piece is held firmly in a lathe chuck.

2. The cutting tool is set in a tool post such that the point of the Cutting tool coincides with the lathe axis.

3. The machine is switched on to revolve the work piece at the selected speed.

4. By giving Cross feed and longitudinal feed to the cutting tool, the facing and turning operations are done respectively.

5. The speed of the work piece is reduced.

6. The knurling operation is done using knurling tool.

7. Again the machine is switched on.

8. The machine is switched off.

9. The work piece is removed from the chuck and all the dimensions are measured and checked.

RESULT

The given work piece as shown in fig. is subjected to facing, plain turning, knurling operations to become a finished work piece as shown in fig.

7. INTERNAL THREAD CUTTING BY USING A LATHE

AIM

To machine a work piece by facing, plain turning and internal thread cutting operations using a lathe.

MATERIALS REQUIRED

• Mild steel polished round rod - f 25 X 100 mm

TOOLS REQUIRED

_ Lathe machine

_ Outside Caliper

_ Turning tool

_ Steel Rule .

_ Vernier Caliper

_ Internal V – thread cutting tool

FORMULA

1) ***Time taken for internal threads:***

$$T = \frac{\text{Length of the cut}}{[\text{Pitch x rpm}]} \times \text{Number of cuts}$$

2) ***Number of cuts:***

$$T = \frac{32}{\text{Threads per 'cm'}} \text{ for external threads}$$

PROCEDURE

1. The given work piece is held firmly in a lathe chuck.

2. The cutting tool is set in a tool post such that the point of the Cutting tool coincides with the lathe axis.

3. The machine is switched on to revolve the work piece at the selected speed.

4. By giving Cross feed and longitudinal feed to the cutting tool, the facing and turning operations are done respectively.

5. The speed of the work piece is reduced.

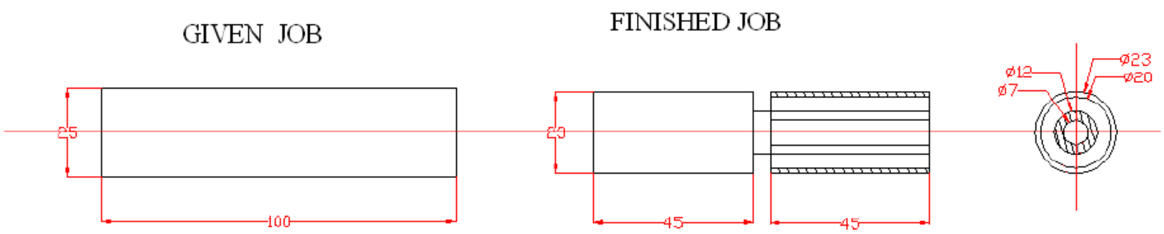
6. The machine is switched off and the change gears of calculated teeth(as per calculation) are connected.

7. Again the machine is switched on.

8. The internal thread cutting operation is done using internal thread cutting tool by engaging thread cutting mechanism.

9. The machine is switched off.

10. The work piece is removed from the chuck and all the dimensions are measured and checked.



ALL DIMENSIONS ARE IN mm

CALCULATION

The number of teeth on change gears is calculated using the following formula:

Driver teeth/ Driven teeth = Pitch of the work / pitch of the lead screw

RESULT

The given work piece as shown in fig. is subjected to facing, plain turning, and internal thread cutting operations to become a finished work piece as shown in fig.

8. ECCENTRIC TURNING OPERATION BY USING A LATHE

AIM

To machine a work piece by facing, plain turning, eccentric operations by use

a four jaw chuck lathe.

MATERIALS REQUIRED

• Mild steel polished round rod - f 25 X 100 mm

TOOLS REQUIRED

_ Four jaw chuck lathe

_ Outside Caliper

_ Turning tool

_ Vernier caliper

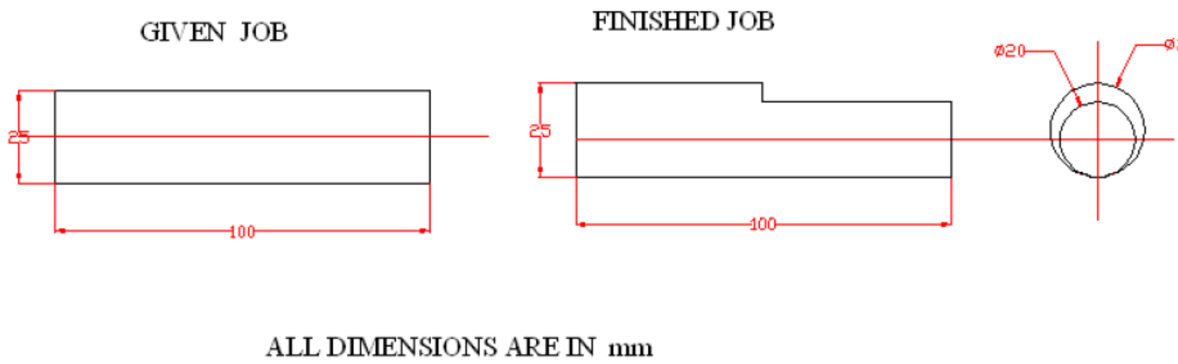
_ Steel Rule

FORMULA

1) Speed , N = 1000 x s / _ x D

2) No. of passes = D-d / 2 x depth of cut

3) Time for eccentric turning = L / F x N



PROCEDURE

1. The given work piece is held firmly in a lathe chuck.

2. The cutting tool is set in a tool post such that the point of the Cutting tool coincides with the lathe axis.

3. The machine is switched on to revolve the work piece at the selected speed.

4. By giving Cross feed and longitudinal feed to the cutting tool, the facing and turning operations are done respectively.

5. The speed of the work piece is reduced.

6. The four jaw chuck is manually adjusted for the offset purpose to make the eccentricity.

7. Again the machine is switched on.

8. The machine is switched off.

9. The work piece is removed from the chuck and all the dimensions are measured and checked.

RESULT

The given work piece as shown in fig. is subjected to facing, plain turning, knurling operations to become a finished work piece as shown in fig.

9. MACHINING HEXAGON FROM ROUND ROD BY USING A MILLING MACHINE

AIM

To machine a hexagon in the given work piece to the dimensions as shown in the figure using Shaping Machine.

TOOLS REQUIRED

_ Milling Machine,

_ Scriber, Divider,

_ Steel Rule,

_ Chalk piece,

_ Bevel Protractor.

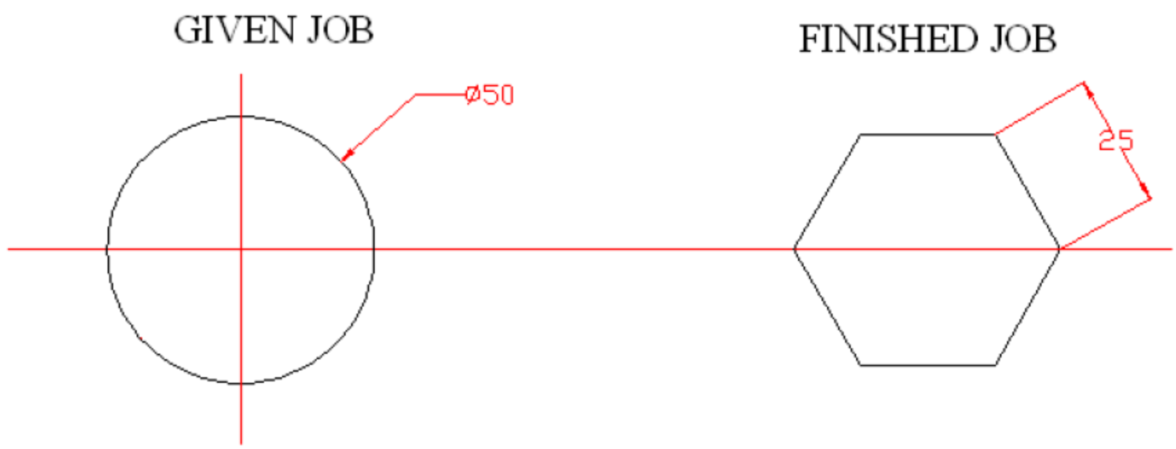
FORMULA

1) ***Time taken for milling:***

$$T = \frac{\text{Length of the job + added table travel}}{(\text{feed / rev}) \times (\text{r.p.m})}$$

2) ***Feed / rev :***

Feed / rev = {feed per teeth} X {no. of cutter teeth}



ALL THE DIMENSIONS ARE IN'mm'

PROCEDURE

1. The given work piece is measured for its initial dimensions.

2. With the help of scriber, mark the hexagon dimensions in the work piece.

3. Fix the work piece in the vice of the shaping machine.

4. After fixing the work piece and the shaping tool, allow the ram to reciprocate.

5. Start the shaping process by giving the required depth by lowering the tool.

6. Slowly increase the depth of cut and repeat the procedure to make the hexagon shape.

7. The work piece is now checked for final dimensions.

RESULT

Thus, a hexagon is machined in the given work piece to the dimensions as shown in the figure using Shaping Machine.

10. MACHINING SQUARE FROM ROUND ROD BY USING A SHAPER

AIM

To generate a square from rounded on the given work piece in a shaper machine.

TOOLS REQUIRED

_ Shaping machine

_ Steel rule

_ Hammer

_ Shaper tool

_ Try Square

FORMULA

1) **Time taken for shaping:**

$$T = \frac{L(1+K)}{S \times 1000} \times \frac{W}{f} \times P$$

Where,

L = Length of forward stroke in 'mm'

K = (time for return stroke / time for forward stroke)

w = width of the job in mm

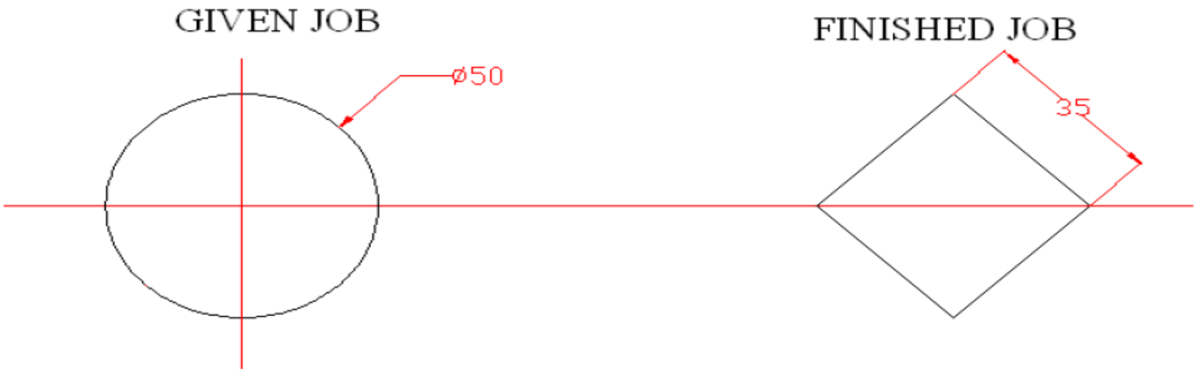
S = Cutting speed in mm

F = feed per stroke

p = number of cuts(or) passes required

2) **No. of cuts P:**

P = Depth of metal removed / Feed per stroke



ALL THE DIMENSIONS ARE IN'mm'

PROCEDURE

1. The job was checked to the given dimensions.

2. The square was scribed in the outer circle of diameter exactly and punching was done.

3. The job was attached in the vice of a shaper.

4. The job was checked for perpendicular dimension.

5. Then the square from round was obtained in the shaper.

6. The work piece was removed and burns are removed with accuracy was checked.

RESULT

Thus the square from round was performed on the given dimension in a shaper machine with the required dimensions.

11. SPUR GEAR CUTTING IN MILLING MACHINE

AIM:

To perform spur gear cutting using vertical milling machine on a work piece.

INTRODUCTION:

Spur gears or straight-cut gears are the simplest type of gear. They consist of a cylinder or disk with the teeth projecting radially, and although they are not straight-sided in form (they are usually of special form to achieve constant drive ratio, mainly involute), the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears can be meshed together correctly only if they are fitted to parallel shafts.

MATERIAL USED

Cast iron blank

TOOLS REQUIRED

1. Vertical Milling machine
2. vernier caliper
3. Holding Materials
4. Milling Tools
5. Mandrel

CALCULATION:

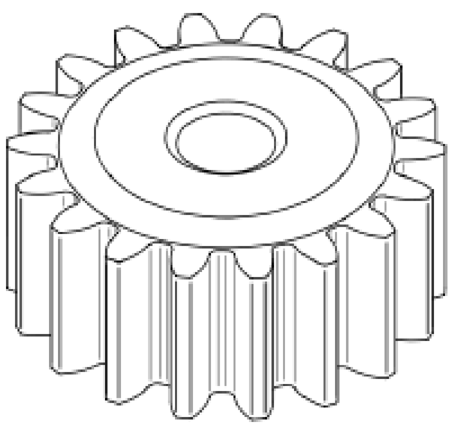
Z = No. of teeth = 23

m = module = 2 mm

Blank Diameter = (Z + 2) m = (23 + 2) 2 = 50 mm

Tooth Depth = 2.25 m = 2.25 * 2 = 4.5 mm

Indexing Calculation = 40 / Z = 40 / 23 = 1 17/23



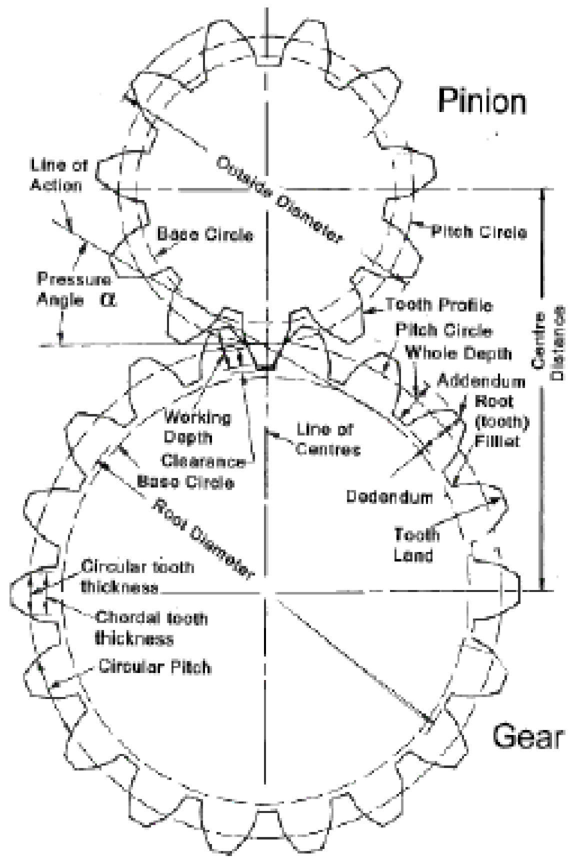


Fig 01 Before Gear cutting **Fig 02After Gear cutting**

PROCEDURE:

Calculate the gear tooth proportions.

Blank diameter = (Z + 2) m

Tooth depth = 2.25 m

Tooth width = 1.5708 m where,

Z = Number of teeth required

m = module Indexing calculation

Index crank movement = 40 / Z

- The dividing head and the tail stock are bolted on the machine table. Their axis must be set parallel to the machine table.
- The gear blank is held between the dividing head and tailstock using a mandrel. The mandrel is connected with the spindle of dividing head by a carrier and catch plate.
- The cutter is mounted on the arbor. The cutter is centred accurately with the gear blank.
- Set the speed and feed for machining.
- For giving depth of cut, the table is raised till the periphery of the gear blank just touches the cutter.
- The micrometer dial of vertical feed screw is set to zero in this position.
- Then the table is raised further to give the required depth of cut.
- The machine is started and feed is given to the table to cut the first groove of the blank.
- After the cut, the table is brought back to the starting position.
- Then the gear blank is indexed for the next tooth space.
- This is continued till all the gear teeth are cut.

RESULT:

The given work piece as is subjected to gear generating operation to become a finished work piece

12. HELICAL GEAR CUTTING IN MILLING MACHINE

AIM:

To perform Helical Gear Cutting using milling machine on a work piece.

INTRODUCTION:

Helical or "dry fixed" gears offer a refinement over spur gears. The leading edges of the teeth are not parallel to the axis of rotation, but are set at an angle. Since the gear is curved, this angling causes the tooth shape to be a segment of a helix. Helical gears can be meshed in parallel or crossed orientations.

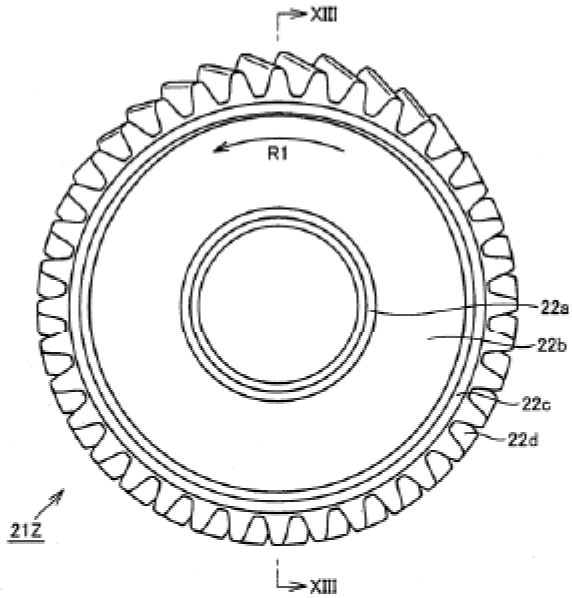
MATERIAL USED

Cast iron

TOOLS REQUIRED

1. Vertical Milling machine
2. vernier caliper
3. Holding Materials
4. Milling Tools

DIAGRAM



HELICAL GEAR FORMULAS

To Obtain	Having	Formula
Transverse Diametral Pitch (P)	Number of Teeth (N) & Pitch Diameter (D)	**p = N/D**
	Normal Diametral Pitch **(Pa)** Helix Angle (w)	**P = P_NCOSw**
Pitch Diameter (D	Number of Teeth (N) & Transverse Diametral Pitch (P)	**D=N/P**
Normal Diametral Pitch (P_N)	Transverse Diametral Pitch (P) & Helix Angle ω	$P_N = P / \cos \omega$
Normal Circular Tooth Thickness **(t)**	Normal Diametral Pitch (P_N)	$\tau = 1.5708/P_N$
Transverse Circular Pitch (p_t)	Diametral Pitch (P) (Transverse	$Pt = \pi /P$
Normal Circular Pitch (p_n)	Transverse Circular Pitch (p)	$P_n = p_t \cos \omega$
Lead (L)	Pitch Diameter and Pitch Helix Angle	$L = \pi D / \tan \omega$

PROCEDURE:

- The dividing head and the tail stock are bolted on the machine table. Their axis must be set parallel to the machine table.
- The gear blank is held between the dividing head and tailstock using a mandrel. The mandrel is connected with the spindle of dividing head by a carrier and catch plate.
- The cutter is mounted on the arbor. The cutter is centred accurately with the gear blank.
- Set the speed and feed for machining.
- For giving depth of cut, the table is raised till the periphery of the gear blank just touches the cutter.
- The micrometer dial of vertical feed screw is set to zero in this position.
- Then the table is raised further to give the required depth of cut.
- The machine is started and feed is given to the table to cut the first groove of the blank.
- After the cut, the table is brought back to the starting position.
- Then the gear blank is indexed for the next tooth space.
- This is continued till all the gear teeth are cut.

RESULT:

The given work piece as is subjected to gear generating operation to become a finished work piece

13. GEAR GENERATION IN SHAPING MACHINE

AIM:

To machine a Spur Gear using a gear Hobbing machine.

MATERIALS REQUIRED:

Cast iron blank

TOOLS REQUIRED:

1. Gear Shaping machine

2. Gear tooth vernier

3. Spanners

PROCEDURE:

- The given work piece is held firmly on the spindle of the gear shapping machine
- The workipice is set at an angle to shaping tool angle for cutting spur gear.
- The change gears are set for the desired speed of work piece and
- The machine is switched on.
- The work piece and Shaper are allowed to remove the metal at the desired speed.
- The work piece is given full deph of cut equals to the tooth depth.
- The cutter is given feed for the full width of the work.
- After machining all gear teeth on the blank the machine is switched off.
- The gear teeth are checked using a gear tooth vernier.

CALCULATION:

Z = No. of teeth = 23

m = module = 2 mm

Blank Diameter = (Z + 2) m = (23 + 2) * 2 = 50 mm

Tooth Depth = 2.25 m = 2.25 * 2 = 4.5 mm

Indexing Calculation = 40 / Z = 40 / 23 = 1 17/23

Fig 01 Before Gear cutting

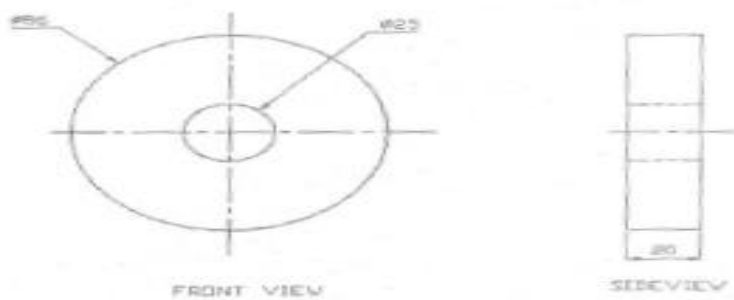
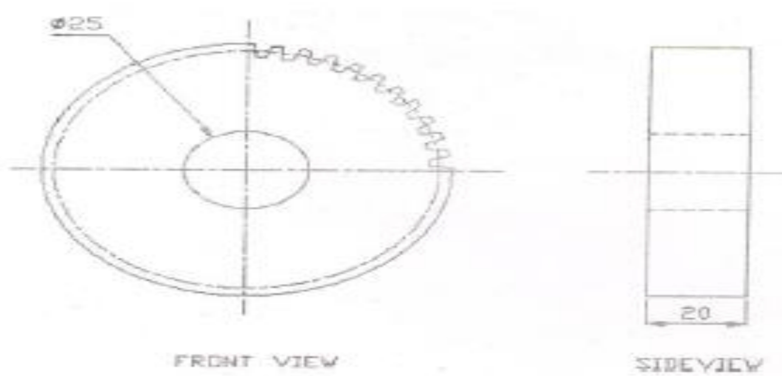


Fig 02After Gear cutting



RESULT:

The given work piece as shown in fig (1) is subjected to gear generating operation to become a finished work piece as shown in fig (2). In gear Shaping Machine.

14. PLAIN SURFACE GRINDING

AIM:

To perform a Plain surface grinding operation on the given work piece for the given dimensions

PRINCIPLE:

The principle involved in this process is to make flat surface on the given work piece. The cutter is moved perpendicular to the work piece and the grinding is done.

REQUIREMENTS

1. Grinding Machine

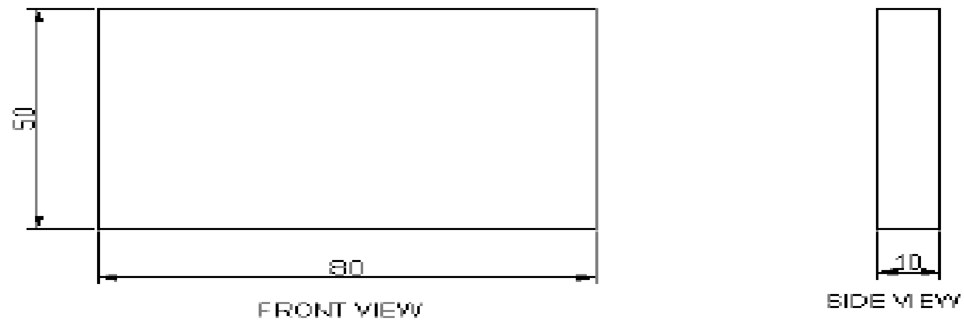
2. Work Piece 100x50x6 mm MS Plate

3. Grinding Wheel

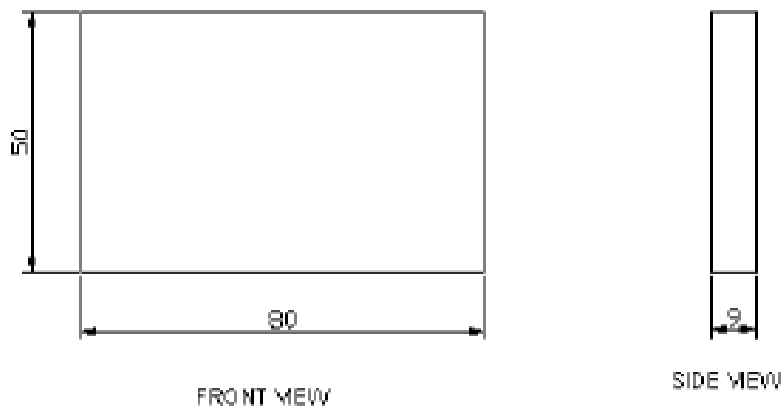
PROCEDURE:

- At first work piece is placed in the magnetic chuck.
- The work piece should be light weight so that it cannot be removed from the magnetic chuck easily.
- Various arrangements regarding the positions of work piece is done.
- Grinding wheel and grinding spindle are kept in position with the work piece.
- Before switching on the motor, necessary steps should taken. For proper grinding process wheel speed, work speed, transverse speed of the wheel in feed, area of contact is to be noted.
- While running the area of contact is adjusted accordingly to the spindle in order to remove the surface.
- It is done slowly to remove the materials on the both sides.
- In surface grinding the stock removal rate is given by Q = bdy Where d =depth of cut (m) b =width of cut (m) y =work velocity (m/s) q =rate of stroke (m3/s)

BEFORE GRINDING



AFTER GRINDING



RESULT:

Thus the surface grinding is done for the given dimensions.

15. CYLINDRICAL GRINDING

AIM:

To grind the cylindrical surface of the given materials as per the given dimensions

REQUIREMENTS:

1. Grinding Machine

2. Grinding Wheel

3. Work Piece

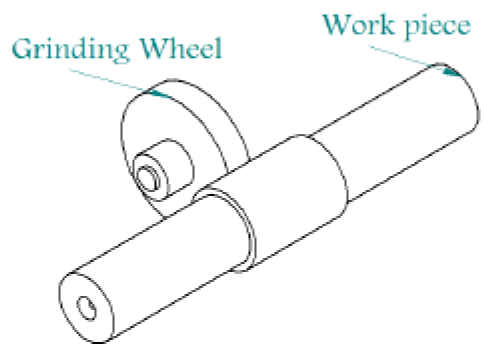
4. Steel rule.

5. Outside calipers.

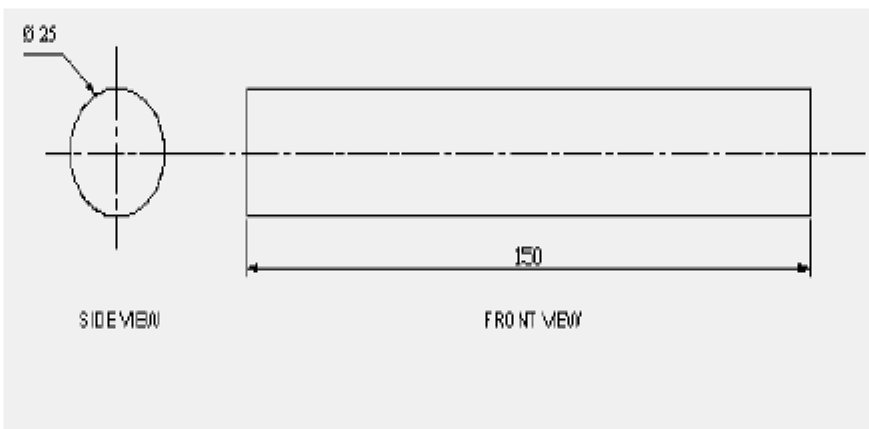
6. Cutting tool.

PROCEDURE:

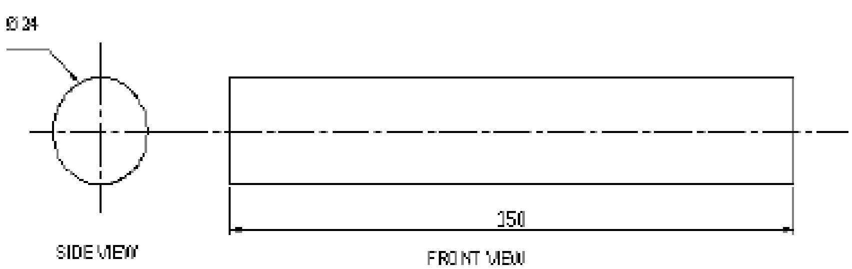
- The given work piece is first fitted in the chuck of the lathe.
- By fitting the tool in tool post the work piece will be reduced to given dimensions.
- First reduce the diameter to 23mm size then reduced the diameter to 15mm and 18mm at the middle.
- By facing the work piece to the tool work piece is reduced to 70mm.
- After the preliminary lathe operation, the work piece is held in the ends of the cylindrical grinder.
- The grinding wheel is turned on and it is moved towards the work piece such that the surfaces of the cylindrical position are grinded to +-0.2mm.



BEFORE GRINDING



AFTER GRINDING



RESULT:

Thus the required dimension of cylindrical surface is obtained.

16. CNC PART PROGRAMMING

AIM:

To Study about the cnc part programming

INTRODUCTION

A Part program is a set of instructions given to a Computerized numerical control (CNC) machine.

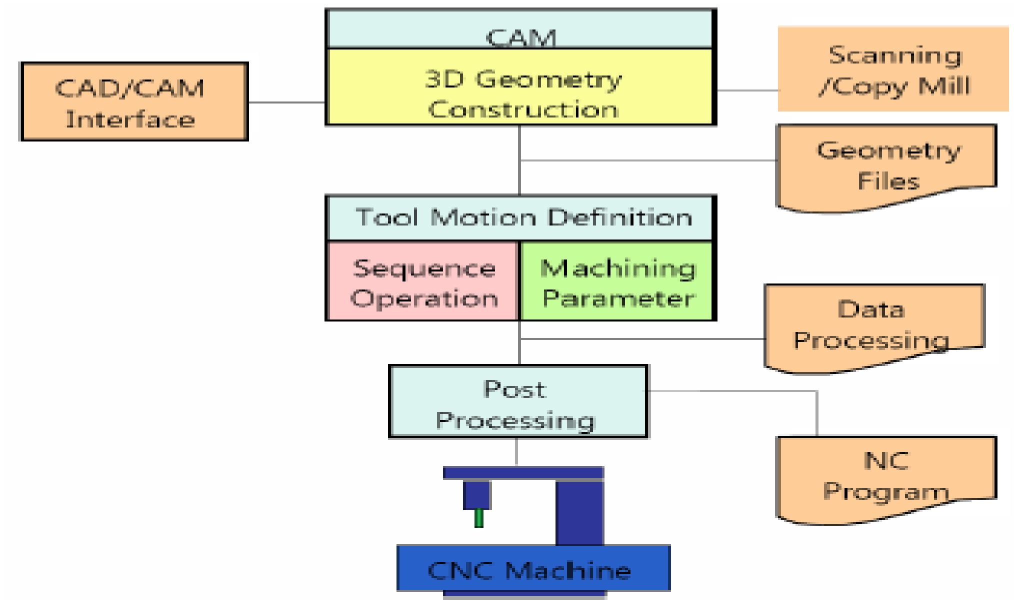
If the complex-shaped component requires calculations to produce the component are done by the programming software contained in the computer. The programmer communicates with this system through the system language, which is based on words. There are various programming languages developed in the recent past, such as APT (Automatically Programmed Tools), ADAPT, AUTOSPOT, COMPAT-II, 2CL, ROMANCE, SPLIT is used for writing a computer programme, which has English like statements. A translator known as compiler program is used to translate it in a form acceptable to MCU.

The programmer has to do only following things :

(a) Define the work part geometry.

(b) Defining the repetition work.

(c) Specifying the operation sequence.



STANDARD G AND M CODES

The most common codes used when programming NC machines tools are G-codes (preparatory functions), and M codes (miscellaneous functions). Other codes such as *F*, *S*, *D*, and *T* are used for machine functions such as feed, speed, cutter diameter offset, tool number, etc. G-codes are sometimes called cycle codes because they refer to some action occurring on the *X*, *Y*, and/or *Z*-axis of a machine tool. The G-codes are grouped into categories such as Group 01, containing codes G00, G01, G02, G03, which cause some movement of the machine table or head. Group 03 includes either absolute or incremental programming. A G00 code rapidly positions the cutting tool while it is above the workpiece from one point to another point on a job. During the rapid traverse movement, either the *X* or *Y*-axis can be moved individually or both axes can be moved at the same time. The rate of rapid travel varies from machine to machine.

G-CODES (PREPARATORY FUNCTIONS)

Code Function

G00 Rapid positioning

G01 Linear interpolation

G02 Circular interpolation clockwise (CW)

G03 Circular interpolation counterclockwise (CCW)

G20 Inch input (in.)

G21 Metric input (mm)

G24 Radius programming

G28 Return to reference point

G29 Return from reference point

G32 Thread cutting

G40 Cutter compensation cancel

G41 Cutter compensation left

G42 Cutter compensation right

G43 Tool length compensation positive (+) direction

G44 Tool length compensation minus (-) direction

G49 Tool length compensation cancels

G 53 Zero offset or M/c reference

G54 Settable zero offset

G84 canned turn cycle

G90 Absolute programming

G91 Incremental programming

M-CODES (MISCELLANEOUS FUNCTIONS)

M or miscellaneous codes are used to either turn ON or OFF different functions, which control certain machine tool operations. M-codes are not grouped into categories, although several codes may control the same type of operations such as M03, M04, and M05, which control the machine tool spindle. Some of important codes are given as under with their function s:

Code Function

M00 Program stop

M02 End of program

M03 Spindle start (forward CW)

M04 Spindle start (reverse CCW)

M05 Spindle stop

M06 Tool change

M08 Coolant on

M09 Coolant off

M10 Chuck - clamping

M11 Chuck - unclamping

M12 Tailstock spindle out

M13 Tailstock spindle in

M18 Tool post rotation reverse

M30 End of tape and rewind or main program end

M98 Transfer to subprogram

M99 End of subprogram

Note : On some machines and controls, some may be differ.

RESULTS

Thus the Study about the cnc part programming has been completed

17. CONTOUR MILLING USING VERTICAL MILLING MACHINE

AIM:

To study the contour milling using vertical milling machine on a work piece

INTRODUCTION:

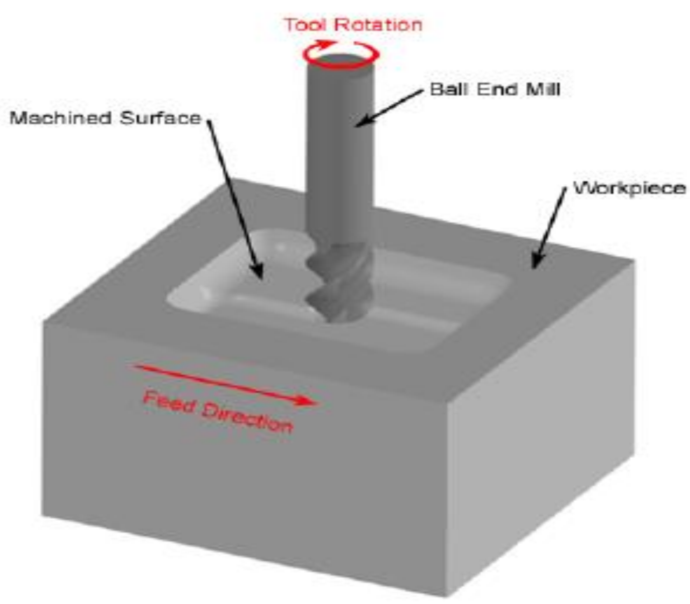
Machining of Irregular Parts and it is an outline especially of a curving or irregular figure

MATERIAL USED

Cast Iron

SURFACE CONTOURING

The end mill, which is used in surface contouring has a hemispherical end and is called ball-end mill. The ball-end mill is fed back and forth across the work piece along a curvilinear path at close intervals to produce complex three-dimensional surfaces. Similar to profile milling, surface contouring require relatively simple cutting tool but advanced, usually computer-controlled feed control system.



USING CODES

G00 - Positioning at rapid speed; Milling and Turning

G01 - Linear interpolation (machining a straight line); Milling and Turning

G02 - Circular interpolation clockwise (machining arcs); Milling and Turning

G03 - Circular interpolation, counter clockwise; Milling and Turning

G04 - Milling and Turning, Dwell

G09 - Milling and Turning, Exact stop

G10 - Setting offsets in the program; Milling and Turning

G12 - Circular pocket milling, clockwise; Milling

G13 - Circular pocket milling, counterclockwise; Milling

G17 - X-Y plane for arc machining; Milling and Turning with live tooling

G18 - Z-X plane for arc machining; Milling and Turning with live tooling

G19 - Z-Y plane for arc machining; Milling and Turning with live tooling

G20 - Inch units; Milling and Turning

G21 - Metric units; Milling and Turning

G27 - Reference return check; Milling and Turning

G28 - Automatic return through reference point; Milling and Turning

G29 - Move to location through reference point; Milling and Turning (slightly different for each machine)

M00 - Program stop; Milling and Turning

M01 - Optional program stop; Turning and Milling

M02 - Program end; Turning and Milling

M03 - Spindle on clockwise; Turning and Milling

M04 - Spindle on counterclockwise; Turning and Milling

M05 - Spindle off; Turning and Milling

M06 - Toolchange; Milling

M08 - Coolant on; Turning and Milling

M09 - Coolant off; Turning and Milling

M10 - Chuck or rotary table clamp; Turning and Milling

M11 - Chuck or rotary table clamp off; Turning and Milling

M19 - Orient spindle; Turning and Milling

M30 - Program end, return to start; Turning and Milling

M97 - Local sub-routine call; Turning and Milling

M98 - Sub-program call; Turning and Milling

M99 - End of sub program; Turning and Milling

RESULTS

Thus the contour milling using vertical milling machine is studied