SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM NAGAR, KATTANKULATHUR - 603 203.

DEPARTMENT OF MECHANICAL ENGINEERING

ME3367 - MANUFACTURING TECHNOLOGY LABORATORY – I

(03rd Semester – Mechanical Engineering)

(ACADEMIC YEAR 2026-2027)

MANUFACTURING TECHNOLOGY LABORATORY-I

MANUAL



SRM VALLIAMMAI ENGINEERING COLLEG

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SRM Nagar, Kattankulathur-603 203.

DEPARTMENT OF MECHANICAL ENGINEERING

ME3367 - MANUFACTURING TECHNOLOGY LABORATORY - I MANUAL

(Regulation 2023)

Name : ……...

Reg. No : ……

Branch : ……

Year & Semester : ……

College - Vision & Mission

Vision

"Educate to Excel in Social Transformation"

To accomplish and maintain international eminence and become a model institution for higher learning through dedicated development of minds, advancement of knowledge and professional application of skills to meet the global demands.

Mission

• To contribute to the development of human resources in the form of professional engineers and managers of international excellence and competence with high motivation and dynamism, who besides serving as ideal citizen of our country will contribute substantially to the economic development and advancement in their chosen areas of specialization.

• To build the institution with international repute in education in several areas at several levels with specific emphasis to promote higher education and research through strong institute-industry interaction and consultancy.

Department - Vision, Mission, PEO, PO, PSO

Vision

To provide quality education and to promote research leading to responsible engineers who will be able to meet the emerging needs of the society.

Mission

M1: Imparting quality education to the students and enhancing their skills to make them competitive mechanical engineers.

M2: To provide facilities and opportunities to the students and faculties for creating, interpreting, applying and disseminating knowledge.

Programme Educational Objectives (PEO's):

PEO1: To prepare our students for successful careers as employees or employers in addition to pursuing higher education.

PEO2: To prepare our students with fundamental knowledge in Mechanical Engineering in order to understand, analyze, design and create products.

PEO3: To develop our students to have an advanced, deep and wide knowledge of multidisciplinary fields.

PEO4: To prepare our students to be ethical professionals and create interest in lifelong learning through self-study.

Programme Outcomes (PO's):

Engineering Graduates Will Be Able To

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical abilityetc. with mutual understanding and respect, and of inclusive attitudes.

Program Specific Outcomes (PSO's):

By the completion of Mechanical Engineering program the student will have following

Program specific outcomes

PSO1: Apply multidisciplinary and mechanical expertise to analyze, design, and produce goods that will meet societal demands.

PSO2: Apply innovative technologies and techniques to create, and launch new systems, services, processes, and products.

SAFETY PRECAUTIONS

To ensure a safe and productive environment, all students must strictly follow the safety rules listed below:

Personal Protective Equipment (PPE)

- Always wear the prescribed uniform, safety shoes (preferably leather with steel toes), and safety gloves.
- Safety goggles must be worn at all times to protect eyes from flying chips and debris.
- Aprons are mandatory to protect clothing and secure loose garments such as ties.
- Avoid loose clothing; wear fitted cotton garments.
- No open-toed shoes or sandals are allowed.
- Remove all jewellery and tie back long hair before entering the lab.

General Conduct

- No horseplay, running, pushing, or startling others inside the lab.
- Do not eat or drink in the lab area.
- Always listen to the teacher/lab instructor and follow instructions carefully.
- Bags and stools should be stored away properly to avoid tripping hazards.

Machine Operation

- Do not operate any machine unless you have received proper instruction from a qualified instructor.
- Never hold a work piece by hand when the machine is running.
- Always use machine guards and keep hands away from moving parts.
- Do not change gears or belts while the machine is operating.
- Avoid taking heavy cuts on long or unsupported jobs.
- Always use the correct size tools and spanners for adjustments.

Tool and Equipment Handling

- Use hand tools with care**,** ensuring both hands are behind the cutting edge.
- Do not clear chips or swarf while the machine is running—use a brush or tool after the machine has stopped.
- Clean metal shavings, oil, and debris after using any machine.
- Report any damage or malfunctioning equipment immediately to the instructor.

Emergency Preparedness

- Know the location of emergency stop buttons and how to use them.
- In case of an accident or emergency, alert the instructor immediately and use the stop controls if necessary.

Cleanliness and Housekeeping

- Clean your workspace after completing tasks.
- Ensure the area around machines is clear and free from oil, grease, or any obstructions.
- Return all tools to their designated storage area.

Learning and Patience

- Ask questions if you do not fully understand any procedure or machine operation.
- Be patient and never rush during practical work.
- Always perform practical tasks only under supervision until fully trained.

Note: *Violations of safety protocols may result in disciplinary action and removal from lab activities.*

SYLLABUS

ME3367 MANUFACTURING TECHNOLOGY LABORATORY – 1 L T P C
0 0 4 2

OBJECTIVE:

To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required in the core industries.

LIST OF EXPERIMENTS

Machining and Machining time estimations for:

1. Taper Turning operation and Machining time estimations for taper turning operation
2. External Thread cutting
3. Internal Thread Cutting
4. Eccentric Turning
5. Knurling operation and Machining time estimations for knurling operation
6. Square Head Shaping
7. Hexagonal Head Shaping
8. Fabrication of simple structural shapes using Arc welding /Gas Metal Arc Welding
9. Joining of plates and pipes using AW/GMA / SAW welding
10. Preparation of green sand moulds
11. Manufacturing of simple sheet metal components using shearing and bending operations
12. Manufacturing of sheet metal components using metal spinning on a lathe

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon the completion of this course the students will be able to

1. Execute precision machining operations, including Taper, Eccentric, and Thread turning on a lathe, and calculate machining time estimations.
2. Produce geometric profiles like square and hexagonal heads using a shaping machine and perform basic drilling/milling operations to meet dimensional specifications.
3. Apply welding techniques to fabricate structural shapes and join pipes/plates while adhering to industrial safety and quality standards.
4. Prepare green sand moulds using patterns and tools, demonstrating an understanding of the foundry process and mold cavity.
5. Fabricate sheet metal components (trays, funnels) using shearing, bending, and metal pinning, applying fundamental knowledge of material deformation.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S. NO	NAME OF THE EQUIPMENT	QTY
1.	Centre Lathes	7 Nos.
2.	Horizontal Milling Machine	1 No
3.	Vertical Milling Machine	1 No
4.	Shaper	1 No
5.	Arc welding transformer with cables and holders	2 Nos.
6.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit	1 No
7.	Moulding table, Moulding equipment	2 Nos.
8.	Sheet metal forming tools and equipment	2 Nos.

CO –PO and CO – PSO MAPPING

ME3367	PROGRAM OUTCOMES											PSO's	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	3	-	-	-	2	-	1	-	2	-	1	3	2
CO2	3	-	-	-	1	-	1	-	2	-	1	2	3
CO3	3	-	-	-	3	-	1	-	2	-	1	3	2
CO4	3	-	-	-	3	-	1	-	2	-	1	3	2
CO5	2	-	-	-	2	-	1	-	2	-	1	3	2
Average	**3**	**-**	**-**	**-**	**2.2**	**-**	**1**	**-**	**2**	**-**	**1**	**2.8**	**2..2**

(1-LOW, 2-MEDIUM, 3- HIGH)

LIST OF EXPERIMENTS

CYCLE - 1

1. **Study of Lathe**
2. Step Turning and Knurling Operation
3. Taper Turning by Compound Rest Method
4. Eccentric Turning
5. Internal and External Thread Cutting on Lathe
6. Milling a Hexagonal Shape on A Round Workpiece
7. Square Shaping of a Round Workpiece using Shaping Machine

CYCLE - 2

8. Pipe-to-Pipe Arc Welding
9. Arc Welding of a Vertical Pipe to a Horizontal Flat Plate
10. Preparation of Green Sand Mould using a Solid Pattern and Production of a Simple Casting
11. Preparation of Green Sand Mould using a Split Pattern and Study of Alignment and Gating System
12. Fabrication of a Hexagonal Sheet Metal Prism using Cutting, Bending, and Seam/Lock Joint Techniques
13. Fabrication of a Conical Component from a Flat Sheet Metal Using Cutting, Layout Marking, and Rolling Operations
14. CNC Turning Operation (Facing and Step Turning) **[Content Beyond Syllabus].**

CONTENTS

S.NO.	DATE	NAME OF THE EXPERIMENT	MARKS	SIGN
1				
2				
3				
4				
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6				
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STUDY OF LATHE

Expt. No:

Date:

INTRODUCTION

Lathe is one of the most versatile and widely used machine tools all over the world. It is commonly known as the mother of all other machine tool. The main function of a lathe is to remove metal from a job to give it the required shape and size. The job is secure1y and rigid1y held in the chuck or in between centers on the lathe machine and then turn it against a single point cutting tool which wi1l remove meta1 from the job in the form of chips. Fig. 1 shows the working principle of lathe. An engine lathe is the most basic and simplest form of the lathe. It derives its name from the early lathes, which obtained their power from engines. Besides the simple turning operation as described above, lathe can be used to carry out other operations also, such as drilling, reaming, boring, taper turning, knurling, screw thread cutting, grinding etc.

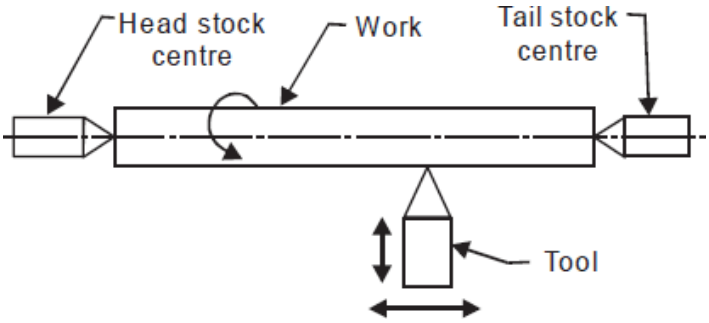


Fig.1. Working principal of lathe machine

CONSTRUCTION OF LATHE MACHINE

A simple lathe comprises of a bed made of grey cast iron on which headstock, tailstock, carriage and other components of lathe are mounted. Fig. 2 shows the different parts of engine lathe or central lathe. The major parts of lathe machine are given as under:

1. Bed
2. Head stock

3. Tailstock

4. Carriage

5. Feed mechanism

6. Thread cutting mechanism

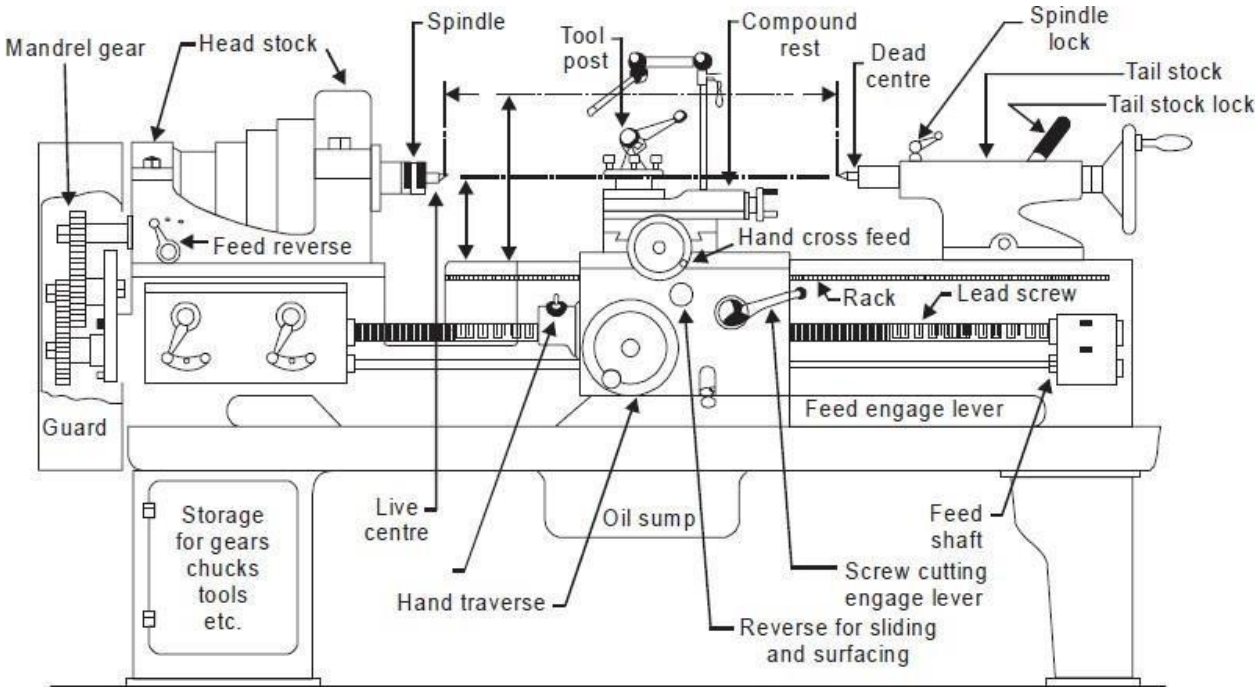


Fig.2 Different parts of engine lathe or central lathe

Bed

The bed of a lathe machine is the base on which all other parts of lathe are mounted. It is massive and rigid single piece casting made to support other active parts of lathe. On left end of the bed, headstock of lathe machine is located while on right side tailstock is located. The carriage of the machine rests over the bed and slides on it. On the top of the bed there are two sets of guideways-inner ways and outer ways. The inner ways provide sliding surfaces for the tailstock and the outer ways for the carriage. The guideways of the lathe bed may be flat and inverted V shape. Generally, cast iron alloyed with nickel and chromium material is used for manufacturing of the lathe bed.

Head Stock

The main function of headstock is to transmit power to the different parts of a lathe. It comprises of the headstock casting to accommodate all the parts within it including gear train arrangement. The main spindle is adjusted in it, which possesses live centre to which the work can be attached. It supports the work and revolves with the work, fitted into the main spindle of the headstock. The cone pulley is also attached with this arrangement, which is used to get various spindle speed through electric motor. The back-gear arrangement is used for obtaining a wide range of slower speeds. Some gears called change wheels are used to produce different velocity ratio required for thread cutting

Tail Stock

Fig. 3 shows the tail stock of central lathe, which is commonly used for the objective of primarily giving an outer bearing and support the circular job being turned on centers. Tail stock can be easily set or adjusted for alignment or non-alignment with respect to the spindle centre and carries a centre called dead centre for supporting one end of the work. Both live and dead centers have 60° conical points to fit centre holes in the circular job, the other end tapering to allow for good fitting into the spindles. The dead centre can be mounted in ball bearing so that it rotates with the job avoiding friction of the job with dead centre as it important to hold heavy jobs.

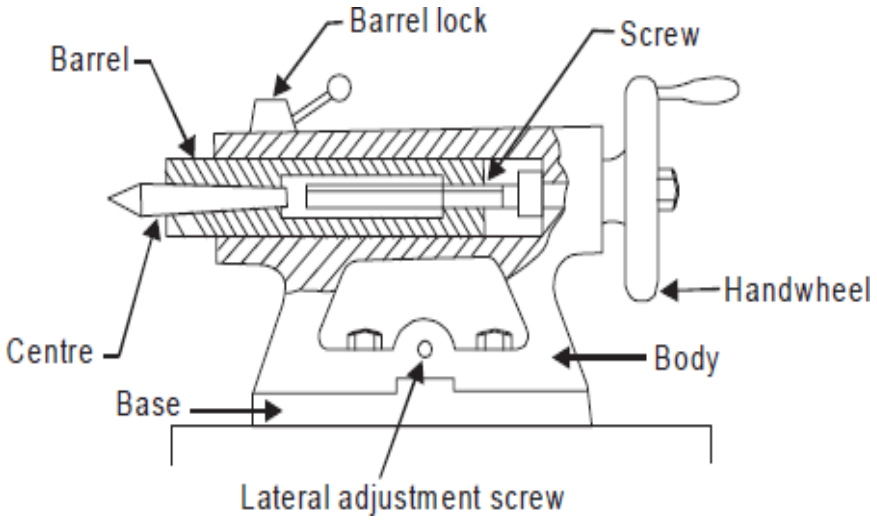


Fig.3 Tail stock of central lathe

Carriage

Carriage is mounted on the outer guide ways of lathe bed and it can move in a direction parallel to the spindle axis. It comprises of important parts such as apron, cross-slide, saddle, compound rest, and tool post. The lower part of the carriage is termed the apron in which there are gears to constitute apron mechanism for adjusting the direction of the feed using clutch mechanism and the split half nut for automatic feed. The cross-slide is basically mounted on the carriage, which generally travels at right angles to the spindle axis. On the cross-slide, a saddle is mounted in which the compound rest is adjusted which can rotate and fix to any desired angle. The compound rest slide is actuated by a screw, which rotates in a nut fixed to the saddle. The tool post is an important part of carriage, which fits in a tee-slot in the compound rest and holds the tool holder in place by the tool post screw. Fig. 4 shows the tool post of centre lathe.

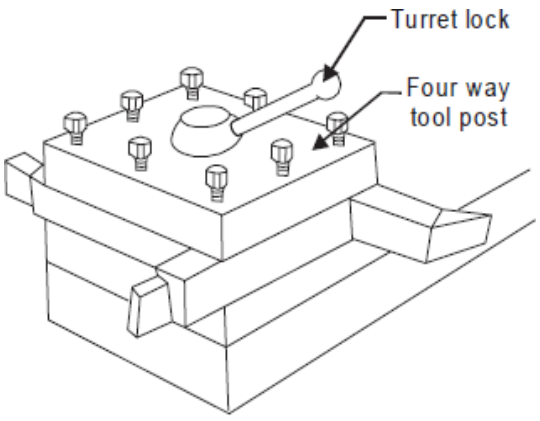


Fig.4 Tool post of centre lathe

Feed Mechanism

Feed mechanism is the combination of different units through which motion of headstock spindle is transmitted to the carriage of lathe machine. Following units play role in feed mechanism of a lathe machine-

1. End of bed gearing
2. Feed gear box
3. Lead screw and feed rod
4. Apron mechanism

The gearing at the end of bed transmits the rotary motion of headstock spindle to the feed gear box. Through the feed gear box, the motion is further transmitted either to the feed shaft or lead screw, depending on whether the lathe machine is being used for plain turning or screw cutting. The feed gear box contains a number of different sizes of gears. The feed gear box provides a means to alter the rate of feed, and the ration between revolutions of the headstock spindle and the movement of carriage for thread cutting by changing the speed of rotation of the feed rod or lead screw. The apron is fitted to the saddle. It contains gears and clutches to transmit motion from the feed rod to the carriage, and the half nut which engages with the lead screw during cutting threads. Thread Cutting Mechanism The half nut or split nut is used for thread cutting in a lathe. It engages or disengages the carriage with the lead screw so that the rotation of the leadscrew is used to traverse the tool along the workpiece to cut screw threads. The direction in which the carriage moves depends upon the position of the feed reverse lever on the headstock.

ACCESSORIES AND ATTACHMENTS OF LATHE

There are many lathe accessories provided by the lathe manufacturer along with the lathe, which support the lathe operations. The important lathe accessories include centers, catch plates and carriers, chucks, collets, face plates, angle plates, mandrels, and rests. These are used either for holding and supporting the work or for holding the tool. Attachments are additional equipment provided by the lathe manufacturer along with the lathe, which can be used for specific operations. The lathe attachment includes stops, ball turning rests, thread chasing dials, milling attachment, grinding attachment, gear cutting attachment, turret attachment and crank pin turning attachments and taper turning attachment.

Lathe centers

The most common method of holding the job in a lathe is between the two centers generally known as live centre (head stock centre) and dead centre (tailstock centre). They are made of very hard materials to resist deflection and wear, and they are used to hold and support the cylindrical jobs.

Carriers or driving dog and catch plates

These are used to drive a job when it is held between two centers. Carriers or driving dogs are attached to the end of the job by a setscrew. A use of lathe dog for holding and supporting the job is shown in Fig. 5. Catch plates are either screwed or bolted to the nose of the headstock spindle. A projecting pin from the catch plate or carrier fits into the slot provided in either of them. This imparts a positive drive between the lathe spindle and job.

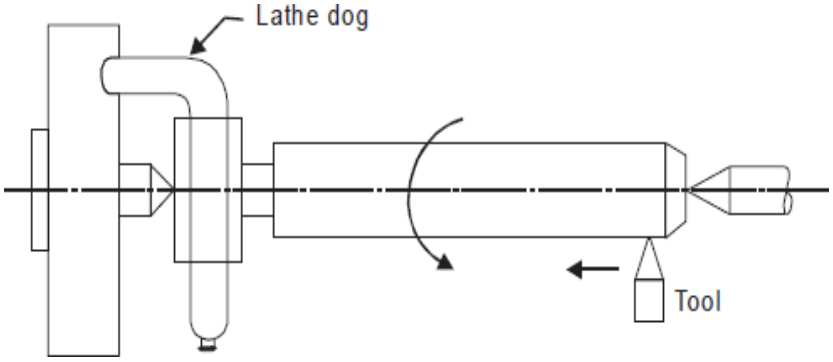


Fig. 5 Lathe dog

Chucks

Chuck is one of the most important devices for holding and rotating a job in a lathe. It is basically attached to the headstock spindle of the lathe. The internal threads in the chuck fit on to the external threads on the spindle nose. Short, cylindrical, hol1ow objects or those of irregular shapes, which cannot be conveniently mounted between centers, are easily and rigidly held in a chuck. Jobs of short length and large diameter or of irregular shape, which cannot be conveniently mounted between centers, are held quickly and rigidly in a chuck. There are a number of types of lathe chucks, e.g.

1. Three jaws or universal
2. Four jaw independent chuck
3. Magnetic chuck
4. Collet chuck
5. Air or hydraulic chuck operated chuck
6. Combination chuck
7. Drill chuck

Face plates

Face plates are employed for holding jobs, which cannot be conveniently held between centers or by chucks. A face plate possesses the radial, plain and T slots for holding jobs or work-pieces by bolts and clamps. Face plates consist of a circular disc bored out and threaded to fit the nose of the lathe spindle. They are heavily constructed and have strong thick ribs on the back. They have slots cut into them, therefore nuts, bolts, clamps and angles are used to hold the jobs on the face plate. They are accurately machined and ground.

Angle plates

Angle plate is a cast iron plate having two faces machined to make them absolutely at right angles to each other. Holes and slots are provided on both faces so that it may be clamped on a faceplate and can hold the job or workpiece on the other face by bolts and clamps. The plates are used in conjunction with a face plate when the holding surface of the job should be kept horizontal.

Mandrels

A mandrel is a device used for holding and rotating a hollow job that has been previously drilled or bored. The job revolves with the mandrel, which is mounted between two centers. It is rotated by the lathe dog and the catch plate, and it drives the work by friction. Different types of mandrels are employed according to specific requirements. It is hardened and tempered steel shaft or bar with 60° centers, so that it can be mounted between centers. It holds and locates apart from its center hole. The mandrel is always rotated with the help of a lathe dog; it is never placed in a chuck for turning the job. A mandrel unlike an arbor is a job holding device rather than a cutting tool holder. A bush can be faced and turned by holding the same on a mandrel between centers. It is generally used to machine the entire length of a hollow job

Rests

A rest is a lathe device, which supports a long slender job, when it is turned between centers or by a chuck, at some intermediate point to prevent bending of the job due to its own weight and

vibration set up due to the cutting force that acts on it. The two types of rests commonly used for supporting a long job in an engine lathe are the steady or centre rest and the follower rest.

SPECIFICATION OF LATHE

The size of a lathe is generally specified by the following means:

(a) Swing or maximum diameter that can be rotated over the bed ways

(b) Maximum length of the job that can be held between head stock and tail stock centres

(c) Bed length, which may include head stock length also

(d) Maximum diameter of the bar that can pass through spindle or collect chuck of capstan lathe.

Fig. 6 illustrates the elements involved in specifications of a lathe. The following data also contributes to specify a common lathe machine.

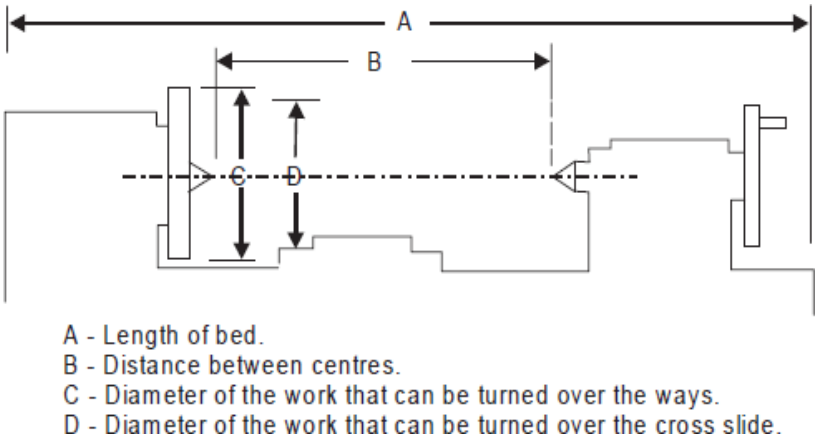


Fig. 6 Specifications of a lathe

(i) Maximum swing over bed

(ii) Maximum swing over carriage

(iii) Height of centers over bed

(iv) Maximum distance between centers

(v) Length of bed

(vi) Width of bed

(vii) Morse taper of center

(viii) Diameter of hole through spindle

(ix) Face plate diameter

(x) Size of tool post

(xi) Number of spindle speeds

(xii) Lead screw diameter and number of threads per cm.

(xiii) Size of electrical motor

(xiv) Pitch range of metric and inch threads etc.

CUTTING SPEED

Cutting speed for lathe work may be defined as the rate in meters per minute at which the surface of the job moves past the cutting tool. Machining at a correct cutting speed is highly important for good tool life and efficient cutting. Too slow cutting speeds reduce productivity and increase manufacturing costs whereas too high cutting speeds result in overheating of the tool and premature failure of the cutting edge of the tool. The following factors affect the cutting speed:

(i) Kind of material being cut,

(ii) Cutting tool material,

(iii) Shape of cutting tool,

(iv) Rigidity of machine tool and the job piece and

(v) Type of cutting fluid being used.

Calculation of cutting speed Cs, in meters per minute

$$Cs = ((22/7) \times D \times N)) /1000$$

Where

D is diameter of job in mm. N is in RPM

FEED

Feed is defined as the distance that a tool advances into the work during one revolution of the headstock spindle. It is usually given as a linear movement per revolution of the spindle or job. During turning a job on the center lathe, the saddle and the tool post move along the bed of the lathe for a particular feed for cutting along the length of the rotating job.

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STEP TURNING AND KNURLING OPERATION

Expt. No:

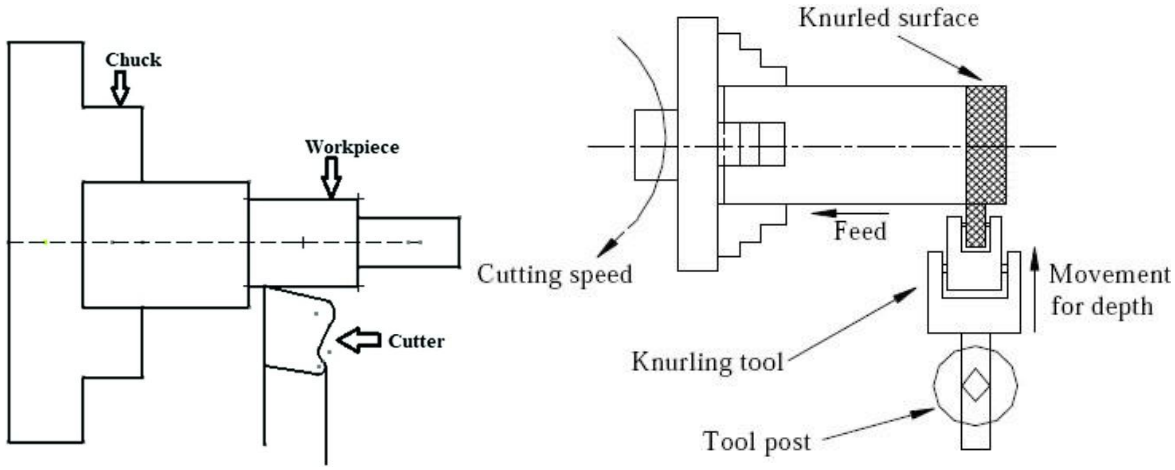
Date:

Aim: To perform step turning and knurling operations on a lathe machine and study the process involved in producing stepped cylindrical surfaces and knurled patterns. Also, to measure the dimensions of the machined part and compare it with the specified drawing.

Tools and Equipment Required:

S. No.	Tool/Equipment	Quantity
1.	Centre Lathe Machine	1
2.	HSS Single Point Cutting Tool	1
3.	Knurling Tool (diamond type)	1
4.	Steel work piece (M.S. Rod)	1
5.	Vernier Caliper / Micrometer	1
6.	Chuck Key	1
7.	Safety Goggles and Gloves	1 pair

Diagram Layout:



- D1, D2: Diameters of steps
- L1, L2: Lengths of each step
- L3: Length of knurled section

Procedure:

A. Step Turning Operation:

1. Fix the workpiece in the chuck of the lathe and tighten using the chuck key.
2. Mark the required lengths of each step using a scriber and steel rule.
3. Mount the single-point cutting tool onto the tool post and align it at center height.
4. Set the lathe speed depending on the material (e.g., for mild steel 200–400 RPM).
5. Start the machine and begin turning the first diameter (D1) to the required size.
6. Traverse the tool longitudinally to maintain the required length (L1).
7. Move the tool to the next section and reduce the diameter to D2.
8. Measure the dimensions using a vernier caliper or micrometer to ensure accuracy.

B. Knurling Operation:

1. Replace the turning tool with a knurling tool in the tool post.
2. Position the knurling tool over the section to be knurled (L3).
3. Feed the tool slowly onto the rotating workpiece.
4. Apply sufficient pressure to allow proper knurling impression (diamond pattern).
5. Move the tool along the length of the section to complete the knurl.
6. Withdraw the tool and stop the machine.
7. Deburr the part and inspect the knurled section.

Results:

Parameter	Measured Value (mm)	Specified Value (mm)
Step Diameter (D_1)		
Step Diameter (D_2)		
Length (L_1)		
Length (L_2)		
Knurled Section Length		

The step turning and knurling were performed successfully. The final component dimensions are within permissible limits.

Precautions:

- Always wear safety goggles while operating the lathe.
- Ensure the tool is sharp and properly aligned.
- Do not leave the chuck key in the chuck after fixing the work piece.
- Avoid applying excess pressure during knurling as it may deform the part.
- Maintain appropriate cutting speed and feed for the material.
- Keep your hands away from the rotating parts.
- Check for secure clamping of the workpiece before starting.
- Use coolant if necessary to prevent overheating.

VIVA QUESTIONS AND ANSWERS

1. **Q:** What is step turning?

   A: Step turning is a lathe operation in which the work piece is turned to different diameters in steps along its length.

2. **Q:** What is the purpose of knurling?

   A: Knurling is done to create a rough surface pattern for better grip, typically on handles or knobs.

3. **Q:** What type of tool is used for knurling?

   A: A knurling tool with hardened rollers (usually diamond or straight pattern) is used.

4. **Q:** What is the feed direction in knurling?

   A: Axial (longitudinal) feed is used while the knurling tool is pressed radially onto the rotating workpiece.

5. **Q:** How do you determine cutting speed for turning?

   A: Cutting speed depends on the material and is given by:

   $V=\pi DN1000V$

   where V = cutting speed (m/min), D = diameter (mm), N = RPM.

6. **Q:** What safety precautions must be followed during knurling?

   A: Use safety goggles, keep hands away from the tool, and ensure proper pressure and alignment.

7. **Q:** What is the typical depth of cut for step turning?

   A: It depends on material and tool, typically around 0.25 to 1 mm per pass.

8. **Q:** Can we perform knurling on non-metallic materials?

   A: No, knurling is generally performed on metals as soft materials may not hold the pattern.

9. **Q:** What is the difference between rough turning and step turning?

   A: Rough turning removes bulk material quickly with large depth of cut; step turning produces multiple diameters with precision.

10. **Q:** Why is coolant not typically used in knurling?

    A: Knurling is a cold-forming process, not cutting; coolant is not mandatory unless excessive heat is generated.

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TAPER TURNING BY COMPOUND REST METHOD

Expt. No:

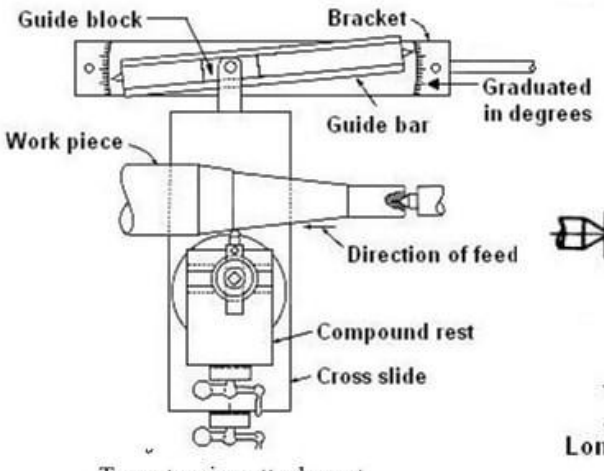
Date:

Aim: To perform taper turning operation on a lathe machine using the compound rest method and to measure and verify the taper dimensions of the finished component.

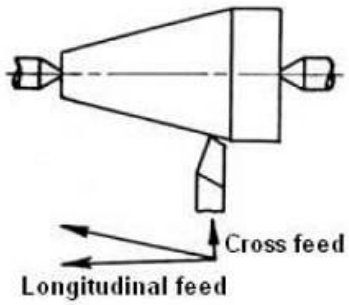
Tools and Equipment Required:

S. No.	Tool/Equipment	Quantity
1.	Centre Lathe Machine	1
2.	Single Point Cutting Tool	1
3.	Steel Workpiece (M.S. Rod)	1
4.	Vernier Caliper / Micrometer	1
5.	Chuck Key	1
6.	Steel Rule, Scriber	1 each
7.	Protractor or Swivel Scale	1
8.	Safety Goggles and Gloves	1 pair

Diagram Layout:



Taper turning attachment



Taper turning by combining feed

Where:

D = Larger diameter

d = Smaller diameter

L = Length of taper

α = Half taper angle

Procedure:

A. Theory:

- Taper turning is the process of gradually reducing the diameter of a cylindrical workpiece over a certain length.
- In the compound rest method, the compound rest is swiveled to the taper angle, and the tool is fed manually.

B. Steps:

1. Mount the workpiece between the chuck and tailstock center and tighten securely.
2. Calculate the taper angle (α) using:

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

where,

D = Larger diameter of taper
d = Smaller diameter
l = Length of taper

3. Swivel the compound rest to the required angle α using a protractor or swivel scale.
4. Clamp the compound rest firmly in the set position.
5. Mount the single-point cutting tool on the tool post and align it at center height.
6. Start the lathe machine at a suitable speed (200–400 RPM for mild steel).
7. Use the compound rest handwheel to feed the tool along the swivelled axis and perform taper turning.

8. Repeat the cuts gradually until the desired taper is achieved.
9. Stop the machine, remove the component, and measure the diameters and length of the taper.
10. Compare with the specified dimensions.

Results:

Parameter	**Measured Value (mm)**	**Specified Value (mm)**
Larger Diameter (D)		
Smaller Diameter (d)		
Taper Length (L)		
Calculated Taper Angle α		
Swivel Angle Set		

The taper was machined using the compound rest method. The final dimensions are within the specified tolerance.

Precautions:

- Ensure the compound rest is accurately swiveled to the correct angle.
- Always clamp the workpiece and tool tightly.
- Maintain center height alignment of the tool.
- Do not exceed recommended cutting speed.
- Feed the tool gradually and smoothly to avoid tool breakage.
- Wear protective goggles and gloves.
- Never leave the chuck key in the chuck.
- Use sharp cutting tools for better finish and accuracy.

Viva Questions and Answers:

1. **Q:** What is taper turning?
   A: Taper turning is a lathe operation where the diameter of a cylindrical job is gradually reduced over a length.

2. **Q:** What is the compound rest method?
   A: In this method, the compound rest is swiveled to the taper angle, and the tool is manually fed along the set angle to produce the taper.

3. **Q:** How is the taper angle calculated?
   A: $\alpha = \tan^{-1}\frac{(D-d)}{2l}$

4. **Q:** What is the maximum taper length that can be machined using the compound rest method?
   A: It is limited by the **travel of the compound rest**, usually short tapers.

5. **Q:** Can internal tapers be produced by the compound rest method?
   A: Yes, provided the tool and setup allow internal turning.

6. **Q:** What are the limitations of the compound rest method?
   A: Suitable only for short tapers and requires manual feed, which may reduce accuracy for longer tapers.

7. **Q:** What are other methods of taper turning?
   A: Tailstock offset method, taper turning attachment, form tool method.

8. **Q:** What is the significance of taper in mechanical design?
   A: Tapers allow easy assembly and disassembly, provide locking effect (e.g., Morse tapers), and alignment.

9. **Q:** What is the advantage of compound rest method?
   A: Simple setup, good for small and precise taper turning operations.

10. **Q:** What is the difference between included angle and half taper angle?
    A: The **included angle** is the full angle of the taper (2α), while **half taper angle (α)** is used for compound rest swiveling.

****

ECCENTRIC TURNING

Expt. No:

Date:

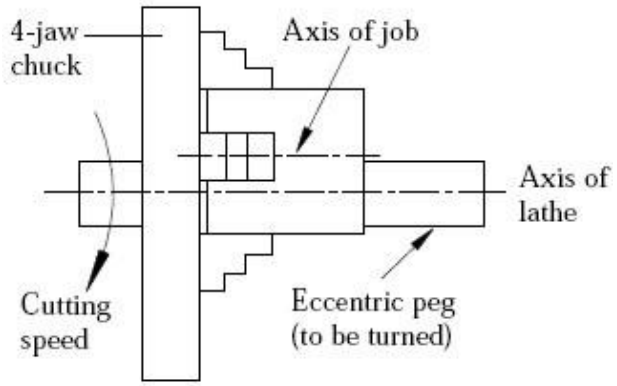
Aim: To perform eccentric turning operation on a lathe machine by mounting the workpiece off-centre and to study the method of producing multiple different axes of rotation on a single workpiece.

Tools and Equipment Required:

S. No.	Tool/Equipment	Quantity
1.	Centre Lathe Machine	1
2.	Three-jaw or Four-jaw Chuck	1
3.	Eccentric Workpiece (M.S. Rod)	1
4.	Dial Indicator / Offset Gauge	1
5.	Single Point Cutting Tool	1
6.	Vernier Caliper / Micrometer	1
7.	Chuck Key	1
8.	Marking Tools (Scriber, Center Punch)	1 each
9.	Safety Goggles and Gloves	1 pair

Diagram Layout:

Eccentric Turned Component



D1 – Concentric diameter

D2 – Eccentric diameter (turned after offsetting)

Offset = distance between center 1 and center 2

Procedure:

1. Prepare the workpiece of required dimensions and mark the multiple centers on the face of the job – one central and one or more off-center (eccentric) axes.
2. Fix the workpiece in the chuck using the central axis and machine the first (concentric) portion to required diameter and length.
3. Remove the workpiece and remount it using an offset setup either by:
    - Adjusting the workpiece in a four-jaw chuck with known offset, or
    - Using an eccentric fixture or faceplate setup.
4. Set the desired eccentricity using a dial indicator or measuring gauge to match the planned offset distance (eccentricity).
5. Mount and align the cutting tool at center height.
6. Start the lathe at appropriate RPM (reduced speed recommended due to imbalance).
7. Slowly perform turning on the eccentric portion to required diameter.
8. Measure the machined sections using calipers/micrometers to ensure dimensional accuracy.
9. Deburr the workpiece, and safely remove it from the machine.

Results:

Parameter	Measured Value (mm)	Specified Value (mm)
Diameter of concentric part		
Diameter of eccentric part		
Length of concentric portion		
Length of eccentric portion		
Eccentricity (offset distance)		

Eccentric turning was performed successfully, and the dimensions closely matched the specified values.

Precautions:

- Ensure the workpiece is securely clamped, especially during eccentric turning to avoid vibration.
- Use lower speeds due to unbalanced rotation in eccentric turning.
- Always wear safety goggles and gloves.
- Align the cutting tool at the correct center height.
- Do not stand directly in front of the rotating workpiece when offset.
- Double-check offset setup using a dial indicator to avoid incorrect dimensions.
- Avoid deep cuts; take multiple shallow passes for better control.
- Use a four-jaw chuck for accurate eccentric settings.

Viva Questions and Answers:

1. **Q:** What is eccentric turning?
   A: Eccentric turning is a lathe operation where different diameters are machined along different axes of rotation on the same workpiece.

2. **Q:** How is eccentricity achieved in turning?
   A: By offsetting the workpiece from the lathe's main axis using a four-jaw chuck or eccentric fixture.

3. **Q:** What type of chuck is best for eccentric turning?
   A: A four-jaw independent chuck allows precise control of the offset and is ideal.

4. **Q:** Why is lower speed recommended in eccentric turning?
   A: Due to imbalance in the rotating mass, lower speed reduces vibration and ensures safety.

5. **Q:** What are common applications of eccentric turning?
   A: Crankshafts, cams, valve actuators, and other mechanical components with multiple axes.

6. **Q:** How do you measure eccentricity?
   A: By using a dial indicator or calculating the distance between the central and eccentric axes.

7. **Q:** Can eccentric turning be done on a CNC lathe?
   A: Yes, using offset programming or multiple setups, CNCs can perform eccentric turning.

8. **Q:** What are the risks in eccentric turning?
   A: Vibration, tool deflection, and improper clamping can lead to poor finish or accidents.

9. **Q:** What is the difference between concentric and eccentric turning?
   A: Concentric turning maintains one central axis throughout; eccentric turning involves multiple rotational axes.

10. **Q:** How do you ensure dimensional accuracy in eccentric turning?
    A: By precisely setting the offset, using accurate measuring instruments, and performing finishing cuts.

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INTERNAL AND EXTERNAL THREAD CUTTING ON LATHE

Expt. No:

Date:

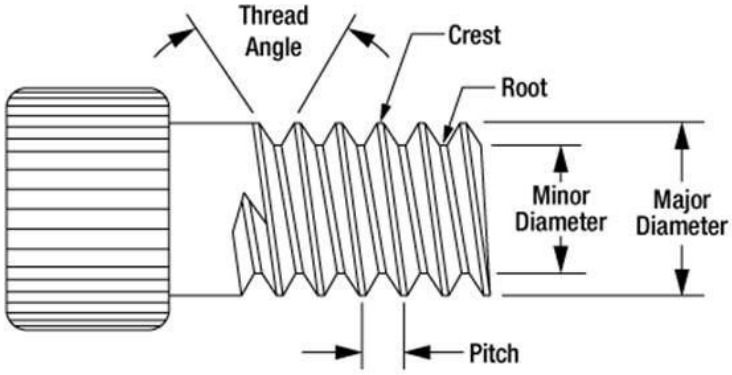
Aim: To perform external and internal thread cutting on a lathe machine using single-point cutting tools and to verify the pitch, depth, and fit of the threads.

Tools and Equipment Required:

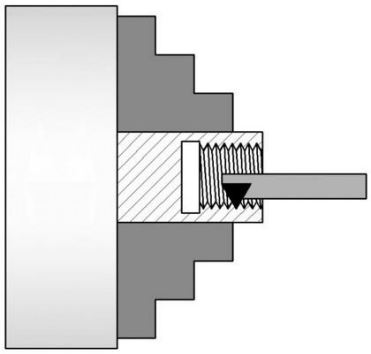
S. No.	Tool/Equipment	Quantity
1.	Centre Lathe Machine	1
2.	External Thread Cutting Tool (V-tool)	1
3.	Internal Threading Tool (Boring bar)	1
4.	Thread Pitch Gauge	1
5.	Vernier Caliper / Micrometer	1
6.	Steel workpiece (M.S. Rod & drilled job)	1 each
7.	Tap and Die Set (for checking)	1 set
8.	Chuck Key	1
9.	Safety Goggles and Gloves	1 pair

Diagram Layout:

External Thread Cutting



Internal Thread Cutting



Pitch (P) = Distance between threads

Depth = 0.613 × Pitch (for 60° threads)

Procedure:

A. External Thread Cutting:

1. Mount the workpiece in the lathe chuck and face the end.
2. Turn the workpiece to the required major diameter for threading using a single-point turning tool.
3. Set the compound rest at 29° for right-hand thread cutting (to allow shearing action).
4. Fix the external threading tool with proper clearance and align it at center height.
5. Engage the lead screw and set the gearbox for the desired pitch.
6. Check thread pitch with a thread pitch gauge and match the lathe's lead screw settings accordingly.
7. Touch the tool to the workpiece, set the dial to zero, and make successive passes by gradually increasing the depth of cut.
8. Disengage the half-nut lever at the end of each pass and return the carriage.
9. Repeat until the desired thread depth is reached.
10. Check thread with a nut or gauge.

B. Internal Thread Cutting:

1. Drill a hole to the required tapping size in the workpiece.
2. Mount the workpiece in the chuck or on a fixture.
3. Use a boring bar with an internal threading tool properly set to the required depth and pitch.
4. Set the gearbox and lead screw similar to the external thread operation.
5. Align the tool at the center height and position it inside the bore.

6. Start threading from the inside moving outwards, taking light passes.
7. Use threading gauge or a matching screw to check the fit.
8. Deburr the hole and edges after threading.

Results:

Parameter	**External Thread**	**Internal Thread**
Nominal Diameter (mm)		
Measured Pitch (mm)		
Thread Depth (mm)		
Length of Thread (mm)		
Thread Fit with Nut/Bolt	Pass/Fail	Pass/Fail

Both external and internal threads were successfully cut, and their dimensions and fit were verified.

Precautions:

- Always ensure correct tool geometry for thread cutting.
- Do not exceed recommended depth of cut in one pass.
- Set the compound rest at 29° for smooth cutting of external threads.
- Use correct pitch settings on the gearbox.
- Ensure the tool is aligned at center height.
- Use a coolant if required to avoid overheating.
- Keep hands away from the rotating chuck and lead screw.
- Use thread pitch gauge frequently to verify accuracy.

Viva Questions and Answers:

1. **Q:** What is thread cutting on a lathe?
   A: It is the process of producing helical grooves (threads) on the external or internal surface of a cylindrical workpiece using a lathe.

2. **Q:** What is the standard thread angle used in most metric threads?
   A: 60 degrees.

3. **Q:** Why is the compound rest set at 29° during thread cutting?
   A: To allow the cutting tool to remove material only on one side (leading edge), ensuring smooth cutting.

4. **Q:** What is the formula for thread depth in a 60° thread?
   A: Depth = 0.613 × Pitch.

5. **Q:** How is pitch measured?
   A: Using a **thread pitch gauge**, or by measuring the distance between adjacent thread crests.

6. **Q:** What is the function of the lead screw in thread cutting?
   A: It provides synchronized motion between the carriage and the spindle for accurate thread pitch.

7. **Q:** What are the types of threads?
   A: External, Internal, Single-start, Multi-start, Metric, Whitworth, Acme, etc.

8. **Q:** How is an internal thread different from an external thread?
   A: Internal threads are cut inside a hole; external threads are cut on the outer surface of a rod.

9. **Q:** What causes poor thread quality?
   A: Improper tool angle, incorrect feed rate, tool deflection, or inaccurate pitch setting.

10. **Q:** What safety precautions are important during thread cutting?
    A: Secure work holding, correct tool alignment, slow feed rates, avoiding loose clothing, and using protective gear.

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MILLING A HEXAGONAL SHAPE ON A ROUND WORKPIECE

Expt. No:

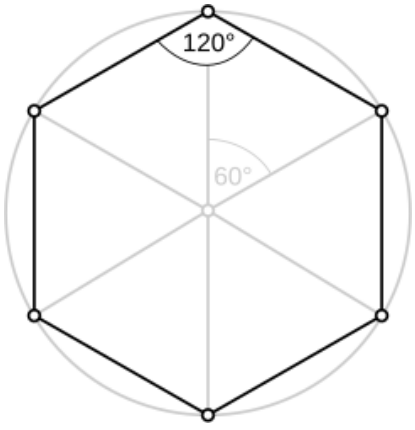
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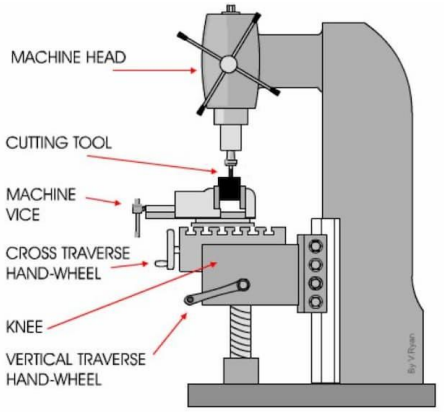
Aim: To machine a hexagonal shape on a given round workpiece using a milling machine as per the specified dimensions, employing proper indexing and cutting operations.

Tools and Equipment Required:

S. No.	Tool/Equipment	Quantity
1.	Vertical Milling Machine	1
2.	Round workpiece (Cast iron. rod)	1
3.	Milling Cutter (End mill – 10 mm size)	1
4.	Dividing Head	1
5.	Chuck or Fixture for holding workpiece	1
6.	Vernier Caliper	1
7.	Height Gauge	1
8.	Spanner Set and Allen Keys	1 each
9.	Safety Goggles and Gloves	1 pair

Diagram Layout:





- **Original shape:** Round
- **Final shape:** Hexagon with 6 equal flat faces
- **Index angle per face:** 360° / 6 = 60°

Procedure:

1. **Mount the round workpiece** securely in a **chuck or fixture** on the **dividing head** of the milling machine.
2. Ensure the workpiece axis is **parallel to the milling table** and cutter.
3. **Select the appropriate milling cutter** (slab or end mill) based on face width and material.
4. Set the **cutting parameters** such as spindle speed, feed rate, and depth of cut as per material specifications.
5. **Index the dividing head** to the initial position and lock it.
6. **Adjust the milling cutter** position to take the required depth of cut for the first face.
7. **Start the milling machine** and feed the cutter slowly across the workpiece to generate the first flat face.
8. **After the first cut, stop the machine**, unlock the dividing head, and rotate it **by 60°** using the indexing plate.
9. **Repeat the milling operation** for all six faces, indexing each time by 60°.
10. After completing all six faces, **remove burrs**, and measure the dimensions using a **vernier caliper**.
11. **Inspect flatness, uniformity**, and corner sharpness of the hexagon.

Results:

Parameter	Measured Value (mm)	Specified Value (mm)
Face Width (flat to flat)		
Face Height (from center)		
Angular spacing between faces	~60°	60°
Surface finish	Good / Poor	Good

The hexagonal profile was successfully generated using proper indexing and milling, and the dimensions are within acceptable tolerance.

Precautions:

- Ensure the workpiece is clamped firmly to avoid vibration.
- Always wear safety goggles and gloves during operation.
- Do not touch the rotating cutter with bare hands.
- Maintain uniform depth of cut across all faces.
- Lock the indexing head properly before each milling pass.
- Use appropriate coolant or lubrication to avoid tool overheating.
- Confirm all face dimensions and angles before finishing the operation.
- Never remove chips with bare hands—use a brush or air blower.

Viva Questions and Answers:

1. **Q:** What is the purpose of using a dividing head in this experiment?
   A: The dividing head allows precise rotation of the workpiece at specific angles (here, 60°) to index the faces for accurate machining.

2. **Q:** How many degrees should the workpiece be indexed for a hexagon?
   A: 360° ÷ 6 = 60° per face.

3. **Q:** What is the formula to calculate indexing crank rotation for a dividing head?
   A: Crank rotation = (40 × N) / T, where N = number of divisions (faces), and T = number of teeth on index plate.

4. **Q:** What is the difference between end milling and slab milling?
   A: End milling cuts with the end and sides of the cutter, while slab milling uses the side of a cylindrical cutter.

5. **Q:** Why is it important to lock the dividing head before each cut?
   A: To prevent any movement and ensure each face is machined precisely at the correct angular position.

6. **Q:** What happens if the indexing is done incorrectly?
   A: The faces will not be equally spaced, resulting in a distorted hexagonal shape.

7. **Q:** What factors affect surface finish in milling?
   A: Cutter speed, feed rate, depth of cut, sharpness of tool, and use of coolant.

8. **Q:** Can this method be used to machine other polygonal shapes?
   A: Yes, by adjusting the indexing angle appropriately (e.g., 90° for square, 45° for octagon).

9. **Q:** What is the function of backlash in dividing heads?
   A: Backlash is the slight movement in gears when changing direction; it must be eliminated by rotating in the same direction before locking.

10. **Q:** How do you ensure dimensional accuracy of the hexagon?
    A: By using precise indexing, maintaining constant depth of cut, and measuring with a Vernier caliper.

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SQUARE SHAPING OF A ROUND WORKPIECE USING SHAPING MACHINE

Expt. No:

Date:

Aim: To perform the square shaping operation on a given round workpiece using a shaping machine and obtain a square block as per the specified dimensions.

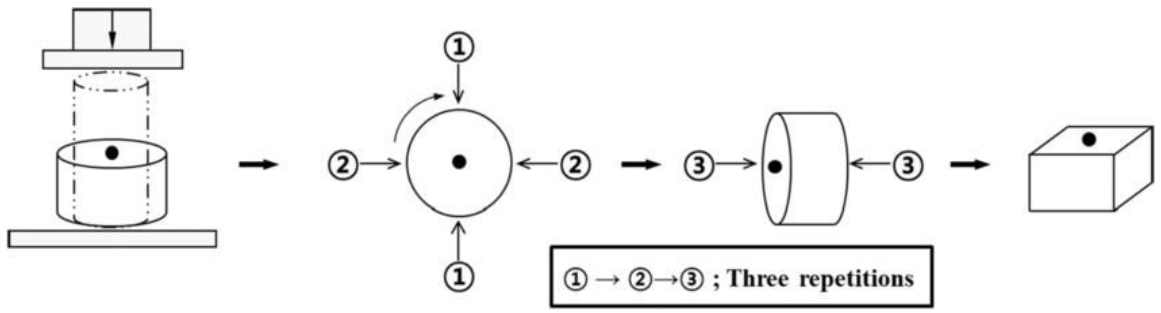
Tools and Equipment Required:

- Shaping Machine
- Round workpiece (Cast iron – 30 mm dia)
- V-block or Fixture
- Single Point Shaping Tool
- Steel Rule/Vernier Caliper
- Marking Tools (Scriber, Surface Gauge)
- Hammer and Center Punch
- Try Square

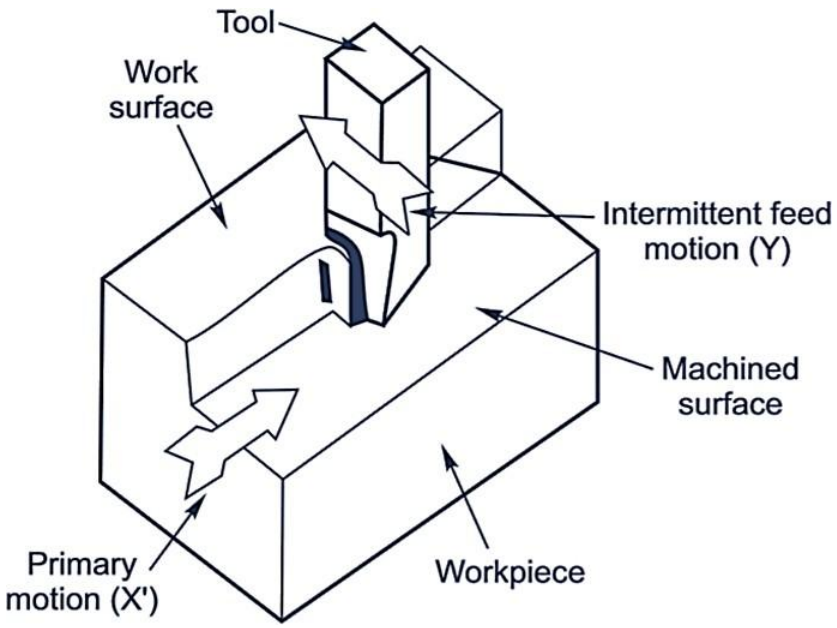
Material Required:

- Cylindrical mild steel workpiece (Ø40 mm × 60 mm length)

Diagram Layout:



- Round workpiece mounted in V-block
- Tool position and direction of ram stroke
- Sequential rotation (90° for 4 sides)
- Final square-shaped block



Procedure:

1. **Workpiece Preparation:**
    - Measure and mark the center on both faces of the round workpiece.
    - Scribe four equidistant lines to divide the surface into four equal parts (90° apart).
2. **Machine Setup:**
    - Mount the shaping tool securely on the tool post.
    - Place the round workpiece in a V-block or use a special fixture to hold it rigidly on the shaping machine table.
    - Adjust the stroke length and the position of the ram.

3. **Marking the Required Shape:**
    - On one end of the workpiece, mark the square cross-section to be machined using scriber and Vernier caliper.
    - The square size should fit within the diameter of the round bar (e.g., a 28 mm square can be made from Ø30 mm rod).
4. **Shaping Operation:**
    - Align the shaping tool with the first flat surface to be cut.
    - Perform the first cut by slowly feeding the tool and allowing the ram to reciprocate.
    - After one face is complete, rotate the workpiece by 90° and repeat the process for the remaining three sides.
5. **Final Check:**
    - After machining all four faces, check the dimensions using a Vernier caliper.
    - Check for squareness using a try square.
    - Perform necessary finishing passes if required.

Result:

The round workpiece is successfully converted into a square block with required dimensions using a shaping machine.

Side	Measured Length (mm)
A	
B	
C	
D	

Squareness checked using try square — ✓ **Acceptable**

Precautions:

- Ensure the workpiece is clamped securely in the fixture or V-block.
- Always check tool alignment before starting the cut.
- Do not exceed the feed rate to avoid tool breakage.
- Keep hands away from the reciprocating ram.
- Use proper personal protective equipment (PPE).
- Check tool sharpness before operation.
- Avoid chatter by providing appropriate tool support.
- Do not leave loose objects on the machine table.
- Clean the machine after operation.
- Always follow lab safety protocols.

Viva Questions and Answers:

1. **Q:** What is the principle of a shaping machine?
   A: It works on the quick return mechanism where the ram moves back and forth to cut material in the forward stroke.

2. **Q:** Why is a V-block used in this operation?
   A: A V-block holds round workpieces securely to prevent rotation during shaping.

3. **Q:** What type of tool is used in shaping?
   A: A single-point cutting tool is used.

4. **Q:** What motion is given to the tool in shaping?
   A: The tool reciprocates in a straight line (horizontal or vertical depending on machine type).

5. **Q:** How many degrees must the workpiece be rotated for each pass in square shaping?
   A: 90 degrees.

6. **Q:** What is feed in shaping?
   A: Feed is the lateral movement of the tool or workpiece per stroke.

7. **Q:** What is quick return mechanism?
   A: It is a mechanism where the return stroke is faster than the cutting stroke to save time.

8. **Q:** How is the square shape ensured on a round bar?
   A: By machining four flat surfaces at 90° intervals using marking and precise positioning.

9. **Q:** What materials are commonly used for shaping operations?
   A: Mild steel, aluminium, brass, etc.

10. **Q:** How do you check squareness after shaping?
    A: By using a try square against adjacent faces.

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PIPE-TO-PIPE ARC WELDING

Expt. No:

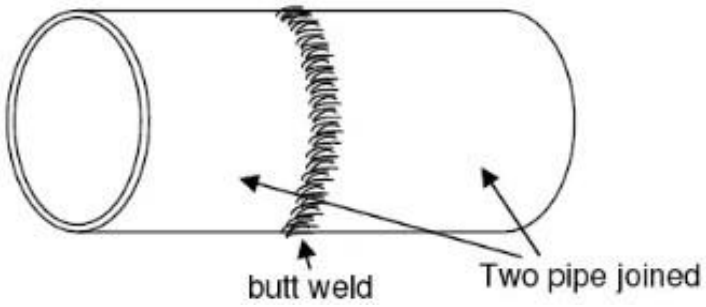
Date:

Aim: To perform arc welding for a pipe-to-pipe joint and to analyze weld bead quality and penetration.

Tools and Equipment Required:

S. No.	Tool/Equipment	Quantity
1.	Arc Welding Machine	1
2.	MS Pipes	2 nos
3.	E7018 Electrodes or ER70S-6 wire	As required
4.	Pipe Cutting & Beveling Tools	1 set
5.	Pipe Alignment Clamp or Jig	1
6.	Welding Gauge, Vernier Caliper	1 each
7.	Grinder & Wire Brush	1 each
8.	Chipping Hammer & Cleaning Tools	1 set
9.	PPE (Gloves, Helmet, Apron, Goggles)	1 set

Diagram Layout:



Procedure:

Preparation:

- Cut both pipes to the required lengths using a pipe cutter or saw.
- Bevel the edges of both pipes at 35°–40° (for groove weld) leaving a root face (~1–2 mm) and root gap (~2–3 mm).
- Clean surfaces (remove rust, oil, or paint) for better arc stability.

Alignment and Tack Welding:

- Position the smaller pipe inside or over the larger pipe, aligning their axes using clamps or fixtures.
- Apply tack welds at 3–4 equally spaced points around the circumference to hold the pipes together.

Welding Operation:

- Set welding current (90–120 A) and choose proper polarity (DCEP for SMAW).
- Start with a root pass, ensuring full penetration into the joint.
- Perform filler passes to build up the groove and fill gaps, maintaining correct arc length (~2–3 mm).
- Use a weaving motion or stringer beads depending on thickness.
- Finish with a cap pass, slightly overlapping the edges for smooth reinforcement.

Post-Weld:

- Remove slag after each pass using a chipping hammer and wire brush.
- Allow the weld to cool slowly (avoid quenching).
- Inspect weld bead visually for defects (porosity, cracks, undercut, etc.).

Results:

Parameter	Measured Value	Specified Value
Weld bead width (mm)		
Weld reinforcement (mm)		
Penetration depth (mm)		
Defects observed		
Overall quality	Acceptable/Not acceptable	

The pipe-to-pipe joint was successfully welded, and weld bead quality and penetration were analyzed.

Precautions:

- Ensure pipes are clamped securely to avoid misalignment during welding.
- Maintain proper electrode angle (usually 70–80° to the surface).
- Avoid excessive current, which may cause burn-through or distortion.
- Keep a consistent arc length to ensure uniform penetration.
- Clean slag between passes to prevent inclusions.
- Always use PPE (helmet with proper shade, gloves, goggles, apron).
- Provide adequate ventilation to avoid inhalation of fumes.
- Do not touch hot welds or pipes with bare hands.

Viva Questions and Answers:

1. **Q:** Why do we bevel the edges of the pipes before welding?
   A: Beveling increases the groove volume, allowing proper penetration and a stronger weld.
2. **Q:** What is the purpose of a root pass in pipe welding?
   A: It ensures full penetration and forms the foundation for subsequent filler passes.
3. **Q:** Why is DCEP (Direct Current Electrode Positive) preferred for SMAW in pipe welding?
   A: It provides deeper penetration and a stable arc.
4. **Q:** How can you avoid lack of fusion in pipe welding?
   A: By maintaining proper arc length, correct electrode angle, and ensuring enough heat input.
5. **Q:** What defects are commonly observed in pipe-to-pipe welding?
   A: Porosity, cracks, undercut, lack of fusion, incomplete penetration, and slag inclusions.
6. **Q:** Why is preheating sometimes required before pipe welding?
   A: To reduce residual stresses, prevent cracking, and improve weld quality.
7. **Q:** What is the difference between root pass and cap pass?
   A: Root pass is the initial weld layer ensuring penetration, while cap pass is the final layer that provides surface finish and reinforcement.
8. **Q:** Why is it necessary to clean slag after every pass?
   A: To avoid slag inclusions that weaken the weld.
9. **Q:** What is the significance of weld bead reinforcement?
   A: Proper reinforcement increases strength, but excessive reinforcement can create stress concentration.
10. **Q:** What tests are used to evaluate pipe weld quality?
    A: Visual inspection, radiographic testing, ultrasonic testing, dye penetrant testing, and bend tests.

****

ARC WELDING OF A VERTICAL PIPE TO A HORIZONTAL FLAT PLATE

Expt. No:

Date:

Aim: To perform arc welding of a vertical mild steel pipe to a horizontal flat plate, simulating base connections for columns or structural supports, and to analyze weld bead quality, strength, and defects.

Tools and Equipment Required:

S. No.	Tool/Equipment	Quantity
1.	Arc Welding Machine	1
2.	MS Pipe (Ø25–80 mm, wall thickness 4–5 mm)	1
3.	MS Flat Plate (10 mm thick, 100 × 50 mm)	1
4.	Electrodes (Ø3.15 mm)	As required
5.	Welding Clamps and Fixtures	1 set
6.	Vernier Caliper, Fillet Weld Gauge	1 each
7.	Grinder, Wire Brush	1 each
8.	Chipping Hammer and Cleaning Tools	1 set
9.	PPE (Gloves, Helmet, Apron, Safety Goggles)	1 set

Diagram Layout:



Procedure:

Preparation:

- Cut and machine the base of the pipe to ensure it sits flush on the plate.
- Mark the center point on the plate for accurate pipe placement.
- Clean the surfaces of the pipe bottom and plate area to remove rust, oil, and paint.

Setup:

- Position the pipe vertically at the marked center and tack weld at 3–4 equally spaced points to hold it upright.
- Check perpendicularity of the pipe using a square or spirit level.

Welding Process:

- Set the welding parameters (e.g., 100–120 A for E7018 electrodes).
- Start welding from one tack point and deposit a fillet weld in short segments (quartering technique) to prevent distortion.
- Continue welding around the circumference, overlapping each weld bead slightly.
- Clean slag and spatter after each segment.
- Apply multiple passes if a larger throat thickness is required.

Post-Weld Operations:

- Grind or smooth the weld bead if necessary.
- Perform visual inspection for uniformity, undercuts, or porosity.

Results:

Parameter	Measured Value	Specified Value
Fillet weld leg size (mm)		
Throat thickness (mm)		
Bead width (mm)		
Visual defects observed		
Weld quality assessment	Acceptable/Not acceptable	

The vertical pipe was successfully welded to the flat plate with a continuous fillet weld and acceptable bead quality.

Precautions:

- Ensure the pipe is clamped firmly and checked for perpendicular alignment.
- Maintain correct electrode angle (70–80°) and travel speed.
- Avoid excessive current to prevent burn-through or undercut.
- Clean slag between passes to avoid inclusions.
- Always use PPE (gloves, helmet with appropriate shade, apron).
- Avoid starting and stopping at the same point; stagger weld starts to prevent defects.
- Do not touch hot surfaces immediately after welding.
- Ensure proper ventilation while welding to avoid harmful fumes.

Viva Questions and Answers:

1. **Q:** Why do we use fillet welds in pipe-to-plate joints?
   A: Fillet welds provide strong corner reinforcement, ideal for attaching pipes to base plates.

2. **Q:** Why is the quartering technique used in circular fillet welding?
   A: It prevents distortion by distributing heat evenly around the pipe.

3. **Q:** What type of electrode is preferred for vertical pipe welding?
   A: Low-hydrogen electrodes like **E7018** are preferred for better mechanical properties.

4. **Q:** How do you check the perpendicularity of a pipe before welding?
   A: Using a **spirit level or try square**.

5. **Q:** Why are multiple passes sometimes required?
   A: To achieve the required weld throat thickness and ensure strength.

6. **Q:** What are common defects in pipe-to-plate welding?
   A: Undercut, porosity, lack of fusion, overlap, and slag inclusions.

7. **Q:** What is the function of preheating thick plates before welding?
   A: To reduce residual stresses and prevent cracking.

8. **Q:** What is the throat thickness in a fillet weld?
   A: The shortest distance from the root of the weld to the face of the fillet.

9. **Q:** Why is arc length important in SMAW?
   A: Incorrect arc length leads to poor penetration and increased spatter.

10. **Q:** How can we test the quality of this weld?
    A: Through **visual inspection, bend tests, dye penetrant testing, or ultrasonic testing**.

****

PREPARATION OF GREEN SAND MOULD USING A SOLID PATTERN AND PRODUCTION OF A SIMPLE CASTING

Expt. No:

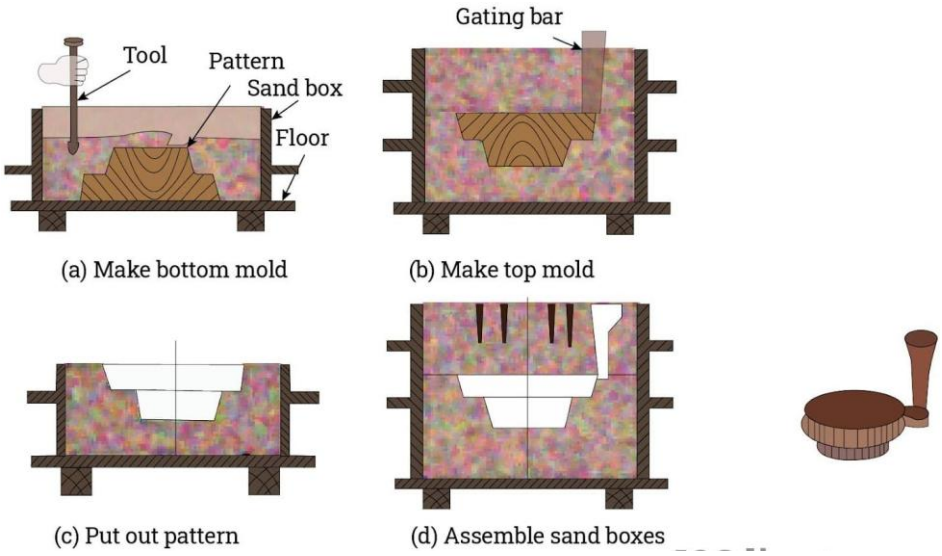
Date:

Aim: To prepare a green sand mould using a solid pattern, perform metal pouring to produce a simple casting (e.g., solid cylinder or cube), and study the mould preparation process and common casting defects.

Tools, Equipment, and Materials Required:

S. No.	Item	Quantity
1.	Moulding boxes (cope & drag)	1 set
2.	Solid pattern	1
3.	Green moulding sand	As required
4.	Moulding board	1
5.	Riddle (sieve)	1
6.	Rammers (peen & butt)	1 set
7.	Strike-off bar	1
8.	Sprue and riser pins	1 set
9.	Vent wire	1
10.	Trowel and lifter	1 set
11.	Parting sand	As required
12.	Ladle for molten metal (demo)	1
13.	Safety gear (gloves, apron, goggles)	1 set

Diagram Layout:



Procedure:

A. Drag Preparation:

- Place the moulding board on a flat surface and position the solid pattern on it.
- Place the drag box (bottom half) over the pattern.
- Sprinkle parting sand lightly over the pattern to prevent sticking.
- Fill the drag with green sand, ramming each layer evenly with the butt end of the rammer.
- Strike off excess sand using the strike-off bar to level the surface.
- Invert the drag carefully so the pattern is facing upward.

B. Cope Preparation:

- Place the cope box on top of the drag, ensuring proper alignment.
- Insert sprue and riser pins in the cope at suitable positions.
- Fill and ram the cope with green sand (start with loose sand near pattern).
- Strike off excess sand and smooth the surface.

C. Pattern Removal:

- Separate the cope and drag carefully.
- Lift out the sprue and riser pins.
- Gently withdraw the pattern using a lifter by tapping lightly to avoid breaking the cavity.
- Cut runners and gates between sprue, riser, and cavity using a trowel.

D. Closing the Mould:

- Inspect both halves for loose sand or damage and repair as needed.
- Close the cope and drag carefully, ensuring proper alignment.

E. Pouring (Demonstration or Simulation):

- Heat and melt the metal (usually aluminium or other low-melting alloys for lab safety).
- Pour the molten metal through the sprue into the mould cavity.
- Allow it to cool and knock out the casting.
- Remove excess metal (sprue, riser) and inspect for defects.

Results:

A simple casting is produced successfully.

- **Casting dimensions:**
  - Length/Height: _____ mm
  - Diameter/Width: _____ mm
- **Defects observed:** _____ (e.g., blowholes, shrinkage, misruns.)

Precautions:

1. Ensure proper **parting sand application** to avoid pattern sticking.
2. **Ram the sand uniformly**—too loose causes collapse, too hard causes difficulty in pattern removal.
3. Do not damage cavity while lifting the pattern.
4. Ensure correct **sprue and riser** dimensions for proper metal flow.
5. Avoid pouring molten metal too quickly (prevents turbulence).
6. Use **PPE** while handling molten metal.
7. Vent the mould properly to allow gases to escape.
8. Inspect and remove moisture in moulding sand to prevent steam explosions.

Viva Questions and Answers:

1. **Q:** What is a solid pattern?
   A: A single-piece pattern used to produce simple shapes without parting surfaces.

2. **Q:** What is the role of a sprue?
   A: It is the vertical channel through which molten metal enters the mould.

3. **Q:** Why do we use a riser in a mould?
   A: To feed molten metal to compensate for shrinkage during solidification.

4. **Q:** What is the function of parting sand?
   A: To prevent the moulding sand from sticking to the pattern.

5. **Q:** Why is venting necessary in moulds?
   A: To allow trapped gases to escape and prevent blowholes in casting.

6. **Q:** What are common casting defects?
   A: Blowholes, misruns, cold shuts, shrinkage cavities, and inclusions.

7. **Q:** What is the ideal composition of green sand?
   A: 85–90% silica sand, 8–10% clay (bentonite), and 4–5% water.

8. **Q:** What is pattern allowance?
   A: Extra material or modification in pattern dimensions to compensate for shrinkage, machining, etc.

9. **Q:** Why is aluminium often used for lab castings?
   A: It has a low melting point, is lightweight, and easy to pour safely.

10. **Q:** What is the difference between a solid and split pattern?
    A: A solid pattern is single-piece; a split pattern is two-piece, used for complex shapes with parting surfaces.

****

PREPARATION OF GREEN SAND MOULD USING A SPLIT PATTERN AND STUDY OF ALIGNMENT AND GATING SYSTEM

Expt. No:

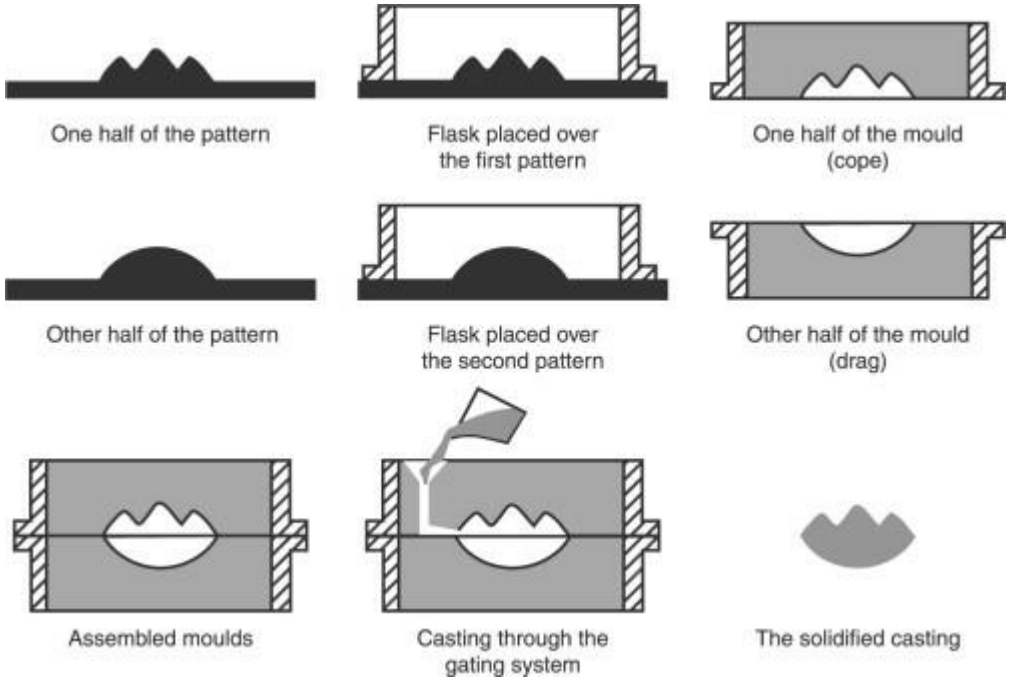
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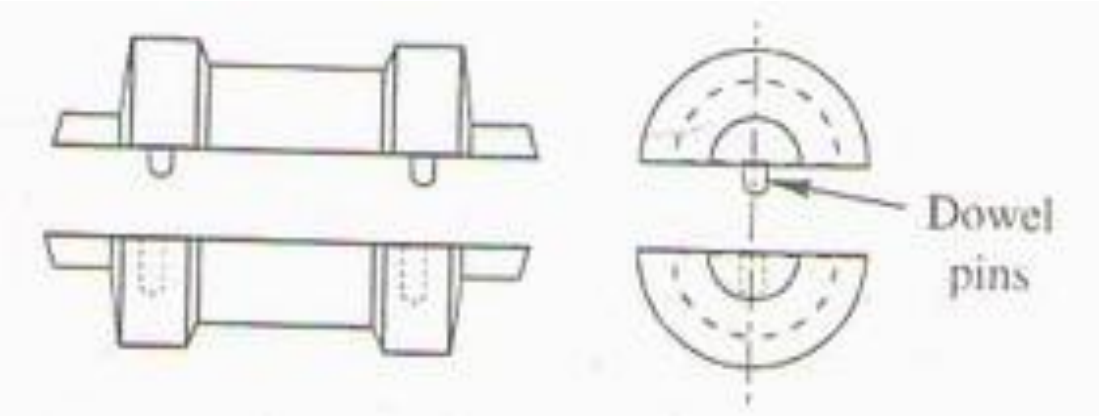
Aim: To prepare a green sand mould using a split (two-piece) pattern, ensuring proper alignment of the cope and drag, and study the design and functioning of the gating system (sprue, runner, and riser).

Tools, Equipment, and Materials Required:

S. No.	Tool/Equipment/Material	Quantity
1.	Split (two-piece) pattern	1 set
2.	Moulding boxes (cope and drag)	1 set
3.	Moulding board	1
4.	Green moulding sand	As required
5.	Riddle (sieve)	1
6.	Rammers (butt and peen ends)	1 set
7.	Strike-off bar	1
8.	Sprue and riser pins	1 set
9.	Vent wire	1
10.	Trowel and lifter	1 set
11.	Parting sand	As required
12.	Safety gear (gloves, apron, goggles)	1 set

Diagram Layout:





Procedure:

A. Drag Preparation:

1. Place the bottom half of the split pattern on the moulding board.
2. Position the drag box around the pattern.

3. Sprinkle parting sand over the pattern to avoid sticking.
4. Sieve and fill green sand over the pattern and ram it uniformly in layers using the butt end of the rammer.
5. Strike off excess sand with the strike-off bar.
6. Invert the drag carefully so the pattern side faces upward.

B. Cope Preparation:

7. Place the top half of the split pattern aligned with the bottom half using dowel pins.
8. Position the cope box on top of the drag.
9. Insert sprue and riser pins at suitable positions.
10. Fill the cope with green sand, ramming in layers.
11. Strike off excess sand and smooth the surface.

C. Pattern Removal and Gating:

12. Separate the cope and drag carefully.
13. Remove the sprue and riser pins.
14. Withdraw both halves of the split pattern carefully to avoid damaging the cavity.
15. Cut runner and gate passages using a trowel.

D. Assembly:

16. Clean both halves of the mould cavity and check alignment of the dowel pins.
17. Close the cope and drag properly, ensuring the gating system is clear.
18. (Optional) Pour molten metal into the sprue and allow it to solidify.

Results:

A green sand mould using a split pattern was successfully prepared.

- **Observation of Gating System:**
    - Sprue diameter: _____ mm
    - Runner width: _____ mm
    - Riser height: _____ mm
- Proper alignment of cope and drag was achieved.

Precautions:

1. Use parting sand generously to avoid pattern sticking.
2. Ensure proper alignment of split pattern halves with dowel pins.
3. Avoid over-ramming, which may damage the pattern or cavity.
4. Do not disturb the mould cavity while removing the pattern.
5. Cut gates and runners smoothly to ensure proper metal flow.
6. Wear protective gear while handling tools and molten metal.
7. Avoid moisture in the sand to prevent steam explosions during pouring.
8. Vent the mould adequately to release gases.

Viva Questions and Answers:

1. **Q:** What is a split pattern?
   A: A pattern made of two halves (cope and drag), used for complex shapes that cannot be removed as a single piece.

2. **Q:** Why are dowel pins used in split patterns?
   A: To ensure proper alignment of the two halves of the pattern.

3. **Q:** What is the purpose of a gating system?
   A: It controls the flow of molten metal into the mould cavity.

4. **Q:** What are the components of a gating system?
   A: Sprue, runner, gate, and riser.

5. **Q:** Why is a riser necessary?
   A: To compensate for metal shrinkage during solidification.

6. **Q:** What is the difference between cope and drag?
   A: Cope is the top half of the mould box, and drag is the bottom half.

7. **Q:** What is parting sand and its purpose?
   A: It is fine sand sprinkled to prevent sand from sticking to the pattern or between cope and drag.

8. **Q:** How do you ensure proper alignment of cope and drag?
   A: By using guide pins (dowels**)** and ensuring the moulding boxes are properly seated.

9. **Q:** What casting defects are common due to improper gating?
   A: Cold shuts, misruns, blowholes, and shrinkage defects.

10. **Q:** Why do we prefer split patterns over solid patterns for complex castings?
    A: Because they allow easy pattern withdrawal and better accuracy for intricate shapes.

****

FABRICATION OF A HEXAGONAL SHEET METAL PRISM USING CUTTING, BENDING, AND SEAM/LOCK JOINT TECHNIQUES

Expt. No:

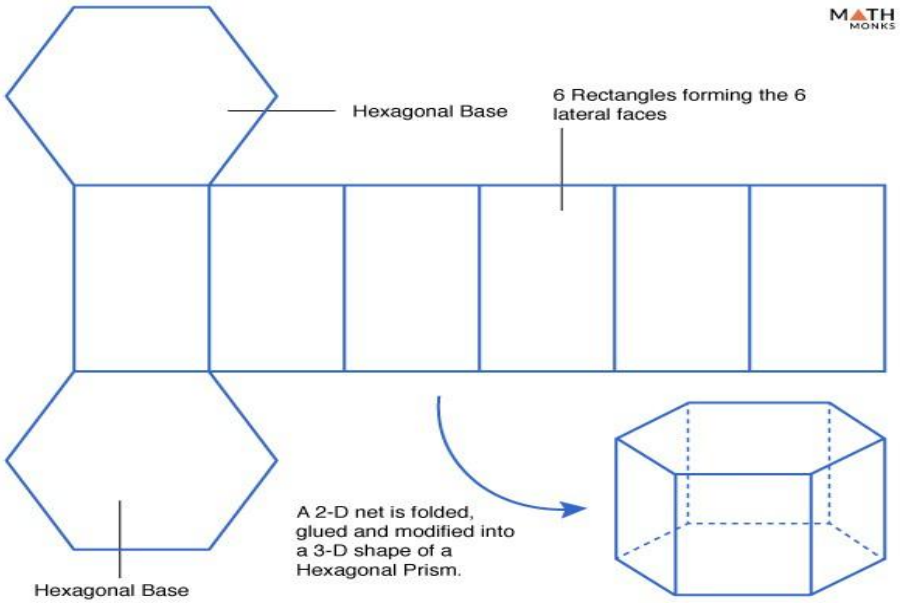
Date:

Aim: To fabricate a hexagonal sheet metal prism from a flat sheet by performing layout marking, cutting, bending, and joining (seam/lock joint) and to study the accuracy and quality of the fabricated prism.

Tools, Equipment, and Materials Required:

S. No.	Tool/Equipment/Material	Quantity
1.	Sheet metal (GI or aluminium, 2–2.5 mm thick)	1 piece
2.	Sheet metal snips/shears	1
3.	Steel ruler, scriber, divider, protractor	1 each
4.	Mallet (wooden or rubber)	1
5.	Stake or folding bar	1
6.	Hand seamer or pliers	1
7.	Riveting tools / seam lock tools	1 set
8.	Files and emery paper	1 set
9.	Try square and clamps	1 set
10.	Safety gloves and goggles	1 set

Diagram Layout:



Procedure:

A. Layout and Cutting:

- Select a sheet metal piece of suitable size and clean its surface.
- Using a ruler, protractor, and divider, mark the development layout of the hexagonal prism (6 rectangles in series + seam allowance).
- Mark additional allowances for seams or lock joints on the edges.
- Cut the layout accurately along the marked lines using sheet metal snips.

B. Scoring and Bending:

- Lightly score along the bend lines using a scriber to ensure accurate folding.
- Place the sheet on a stake or folding bar and bend each face along the lines to form 120° angles (6 faces forming a hexagonal cross-section).
- Check alignment with a try square and adjust angles as needed.

C. Joining:

- Overlap the seam edges and form a single or double lock seam, or alternatively use **rivets** for joining the prism edges.
- Hammer the seam carefully to achieve a tight and uniform joint.

D. Finishing:

- File all sharp edges and smooth the corners using emery paper.
- Inspect the dimensions, alignment, and surface finish of the final hexagonal prism.

Results:

A **hexagonal sheet metal prism** was successfully fabricated.

- **Measured Dimensions:**
  - Height: _____ mm
  - Side length: _____ mm
  - Number of faces: 6 (accurate/inaccurate).
- The quality of the seam joint and surface finish was observed and evaluated.

Precautions:

1. Mark the layout carefully using accurate measuring tools to avoid dimension errors.
2. Cut the sheet slowly with snips to prevent warping or distortion.
3. While bending, avoid excessive hammering which can crack or deform the sheet.
4. Ensure proper overlap for seams to avoid weak joints.
5. Always wear gloves and goggles to prevent injuries from sharp sheet edges.
6. Keep the workpiece firmly clamped while bending and joining.
7. File off burrs after cutting to avoid handling hazards.

Viva Questions and Answers:

1. **Q:** What is a sheet metal development?
   A: It is the flat layout of a 3D shape that, when cut and folded, forms the required object.

2. **Q:** Why is seam or lock joint used in sheet metal work?
   A: To join sheet edges securely without welding, often used for thin sheet metal.

3. **Q:** What angle is required to form a hexagon prism?
   A: Each bend is at 120°, forming 6 faces.

4. **Q:** Why is scoring done before bending?
   A: To create accurate fold lines and achieve sharp, precise bends.

5. **Q:** What are the main sheet metal operations?
   A: Shearing, bending, notching, folding, seaming, and riveting.

6. **Q:** What is the difference between a single seam and a double lock seam?
   A: A single seam involves one fold, while a double lock seam involves two interlocked folds, providing stronger joints.

7. **Q:** Why do we use mallets instead of hammers for bending sheet metal?
   A: Mallets avoid surface damage or dents while forming bends.

8. **Q:** What is the purpose of a folding bar?
   A: It is used as a support and guide for accurate and uniform sheet metal bends.

9. **Q:** What are the advantages of sheet metal fabrication?
   A: Low cost, lightweight, and easy to form into various shapes.

10. **Q:** What safety measures are important in sheet metal work?
    A: Wearing gloves, handling sharp edges carefully, using proper tools, and ensuring sheets are clamped during operations.

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FABRICATION OF A CONICAL COMPONENT FROM A FLAT SHEET METAL USING CUTTING, LAYOUT MARKING, AND ROLLING OPERATIONS

Expt. No:

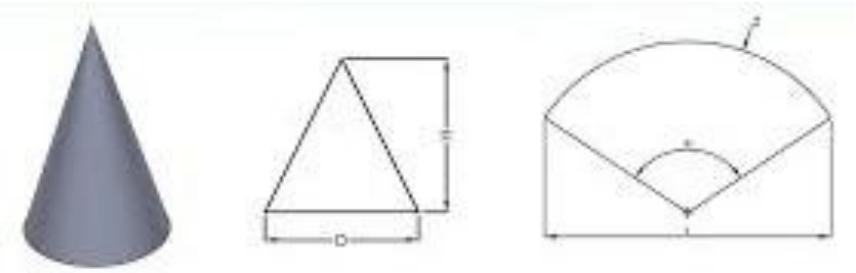
Date:

Aim: To fabricate a conical component from a flat sheet metal by performing cutting, layout marking, and rolling operations, and to study the sheet metal development process for conical shapes.

Tools, Equipment, and Materials Required:

S. No.	Item	Quantity
1.	Sheet metal (GI, or aluminum)	1 (cut piece)
2.	Sheet metal shears/snips	1
3.	Scriber and steel rule	1 each
4.	Divider, compass, and protractor	1 set
5.	Sheet metal roller or hand stakes	1 set
6.	Mallet (wooden or rubber)	1
7.	Rivet set (for edge joining)	As required
8.	Files and emery paper	1 set
9.	PPE (gloves, apron, goggles)	1 set

Diagram Layout:



Procedure:

A. Preparation of Layout:

1. Determine the dimensions of the cone (base diameter D, height H, and slant height L = $\sqrt{(H^2 + (D/2)^2)}$).
2. Calculate the arc length of the sector: S=πDS = \pi DS=πD.
3. On the sheet metal, use a divider and scriber to draw a circular arc of radius L.
4. Mark the arc length S using the divider, forming the sector required for the cone.

B. Cutting:

5. Cut the sheet metal along the marked lines using shears or snips.
6. Deburr and smooth the edges with a file.

C. Rolling and Forming:

7. Gradually roll the cut sector into a conical shape using a sheet metal roller or by hand over a forming stake.
8. Adjust the cone shape until the edges overlap evenly.

D. Joining:

9. Join the overlapping edges using riveting, seam joint, or welding.
10. Ensure the cone shape is symmetrical and dimensions match the design.

E. Finishing:

11. Smooth the surface and edges using a file or emery paper.
12. Inspect the cone for proper dimensions and finish.

Results:

A conical sheet metal component is fabricated successfully.

- **Measured dimensions:**
    - Base diameter: _____ mm
    - Height: _____ mm
    - Slant height: _____ mm
- **Observation:** The fabricated cone matches the calculated dimensions.

Precautions:

1. Perform accurate layout marking to avoid wastage of sheet metal.
2. Use proper PPE to prevent cuts or injuries from sharp edges.
3. Avoid excessive force while cutting or rolling to prevent deformation.
4. Check the cone's circularity and alignment before final joining.
5. Handle tools like snips and mallet carefully to avoid accidents.
6. Remove burrs and sharp edges to prevent injury.
7. Ensure proper overlap for strong edge joining.
8. Do not over-hammer during shaping as it may thin the metal.

Viva Questions and Answers:

1. **Q:** What is sheet metal development?
   A: It is the process of creating a flat pattern from which a 3D shape (like a cone) can be fabricated.

2. **Q:** Why is a sector of a circle used for a cone layout?
   A: Because when rolled, the sector forms the curved surface of the cone.

3. **Q:** How is the slant height of a cone calculated?
   A: L=(H2+(D/2)2)L = \sqrt{(H^2 + (D/2)^2)}L=(H2+(D/2)2), where H is height and D is base diameter.

4. **Q:** What is the purpose of a mallet in sheet metal work?
   A: It shapes or bends the sheet metal without damaging its surface.

5. **Q:** What joining methods are used for sheet metal cones?
   A: Riveting, seam joints, soldering, or welding.

6. **Q:** What are common sheet metal tools for layout marking?
   A: Scriber, divider, protractor, and steel rule.

7. **Q:** Why is deburring necessary after cutting?
   A: To remove sharp edges that can cause injuries or affect joining quality.

8. **Q:** What materials are commonly used in sheet metal cones?
   A: Mild steel, galvanized iron, aluminum, or copper.

9. **Q:** What are the typical applications of sheet metal cones?
   A: Funnels, hoppers, ducting, and chimneys.

10. **Q:** What is the main defect observed during cone fabrication?
    A: Improper circularity due to inaccurate rolling or misalignment of edges.

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CONTENT BEYOND SYLLABUS

CNC TURNING OPERATION

(FACING, STRAIGHT TURNING, AND STEP TURNING)

Expt. No:

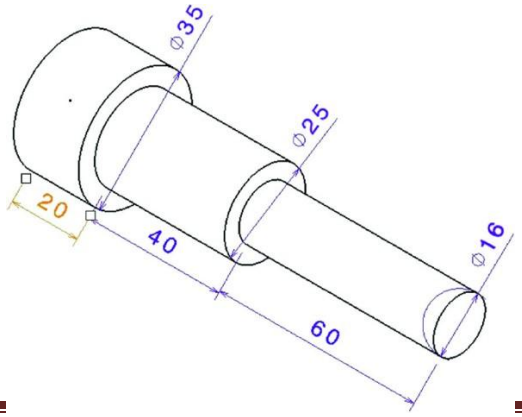
Date:

Aim: To perform facing, straight turning, and step turning operations on a CNC lathe machine using a suitable CNC part program, and to measure the dimensional accuracy of the machined component.

Tools, Equipment, and Materials Required:

S. No.	Item	Quantity
1.	CNC Lathe Machine	1
2.	Mild Steel or Aluminum Workpiece (Ø25 mm × 75 mm)	1
3.	Cutting Tools (Tungsten Carbide Insert Tool)	1 set
4.	CNC Part Program (G & M Codes)	1
5.	Vernier Caliper / Micrometer	1
6.	Coolant (if applicable)	As required
7.	PPE (goggles, gloves, apron)	1 set

Diagram Layout:



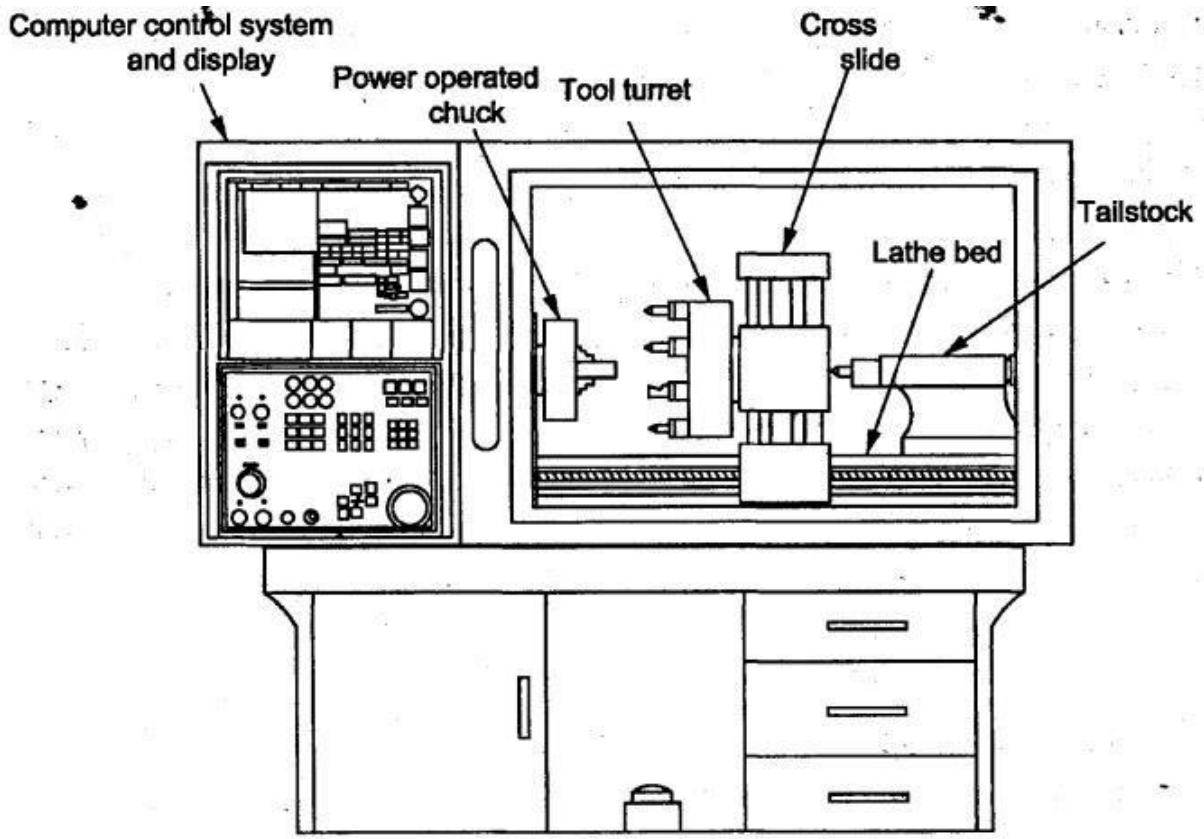


Figure 4.36 CNC Turning center

Procedure:

Step 1: Preparation and Setup

- Mount the cylindrical workpiece firmly in the CNC lathe 3-jaw chuck.
- Set the tool in the turret and define its tool offset using the tool offset menu.
- Load the CNC part program into the machine controller (either by manual entry or via USB/RS-232).

Step 2: CNC Part Programming

A sample program for facing, straight turning, and step turning:

```
%
O0100 (CNC TURNING PROGRAM)
G21  (Programming in mm)
G90  (Absolute programming)
G40 G80 G99  (Cancel tool radius, canned cycles)

T0101 (Select Tool 1, Offset 1)
G96 S200 M03 (Constant surface speed, spindle ON CW)
G00 X30 Z2 (Rapid positioning to start point)
G01 Z0 F0.2 (Facing cut to Z=0)
G00 X30 Z2 (Return)

(STRAIGHT TURNING)
G00 X26 Z2
G01 Z-40 F0.2 (Straight turning to Z = -40 mm)
G00 X30

(STEP TURNING)
G00 X22 Z-40
G01 Z-60 F0.2 (Step turning section)
G00 X30 Z2

M05 (Spindle stop)
M30 (End of Program)
%
```

Step 3: Operation

- Run the program in simulation or single block mode to verify tool paths.
- Start the machining operation with coolant ON (if required).
- Perform facing to smoothen the end surface of the workpiece.

- Perform straight turning to reduce diameter over the specified length.
- Perform step turning to create the required stepped profile.

Step 4: Inspection

- Measure the diameters and lengths of the machined sections using a vernier caliper/micrometer.
- Compare the results with the given specifications.

Results:

Operation	Specified Dimension (mm)	Measured Dimension (mm)
Facing (Length)		
Straight Turning (Ø)		
Step Turning (Ø)		
Step Length		

The component was successfully machined with the required facing, turning, and step turning profiles.

Precautions:

- Verify the CNC program in dry run mode before actual machining.
- Ensure the workpiece is properly clamped to avoid misalignment.
- Set correct tool offsets before starting the operation.
- Use appropriate cutting speed and feed to prevent tool wear.
- Do not open the machine door during operation.
- Use coolant for better surface finish and tool life.
- Always wear safety goggles and protective gear.
- Keep hands away from the moving tool and spindle.

Viva Questions and Answers:

1. **Q:** What is the difference between CNC and conventional turning?
   A: CNC turning is computer-controlled, allowing precise and automated operations, whereas conventional turning is manually controlled.
2. **Q:** What is the purpose of facing in turning?
   A: Facing creates a flat surface on the end of the workpiece and sets the reference length.
3. **Q:** Which G-code is used for linear interpolation?
   A: G01 is used for linear interpolation with feed.
4. **Q:** What is a step turning operation?
   A: It is the turning of a workpiece in steps of varying diameters.
5. **Q:** What does G21 represent?
   A: G21 indicates the programming is in millimeters (metric units).
6. **Q:** Why is tool offset necessary in CNC turning?
   A: Tool offsets define the exact tool position relative to the workpiece for precise machining.
7. **Q:** What is the function of M03 and M05 codes?
   A: M03 starts the spindle clockwise, and M05 stops the spindle.
8. **Q:** What is the difference between absolute (G90) and incremental (G91) programming?
   A: G90 defines positions relative to a fixed zero point, while G91 defines positions relative to the current tool location.
9. **Q:** What is constant surface speed (G96) used for?
   A: It adjusts spindle speed automatically to maintain a constant cutting speed as the diameter changes.
10. **Q:** What are the advantages of CNC turning?
    A: High accuracy, repeatability, reduced human error, complex shapes, and faster production.

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