GUJARAT TECHNOLOGICAL UNIVERSITY

BE-4 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK SOLUTION

Subject Name & Code:
Manufacturing Processes (3141908)

📚 UNIT 1: Introduction to Machine Tools

Q.1 – Give the detailed classification of machine tools. (3 marks)
Appeared in: S25, W23, W22, S24 (each 3 marks)
Ans:
Machine tools are classified as:

- **By cutting motion:** Rotational (lathe, drill) vs. Reciprocating (shaper, planer)
- **By operation:** Turning, Drilling, Milling, Grinding, Broaching, Sawing
- **By automation:** Manual, Semi-automatic, Automatic (CNC)
- **By number of axes:** 2-axis, 3-axis, 5-axis
- **By size/portability:** Bench type, Floor type, Heavy duty

Real-world application: CNC lathes (rotational, multi-axis) are standard in automotive part manufacturing.

Q.2 – Describe primary and auxiliary motions in machine tools. (4 marks)
Appeared in: S25(4), W25(3), W24(4), W23(4), W22(4), S22(4) → Highest: 4 marks
Ans:

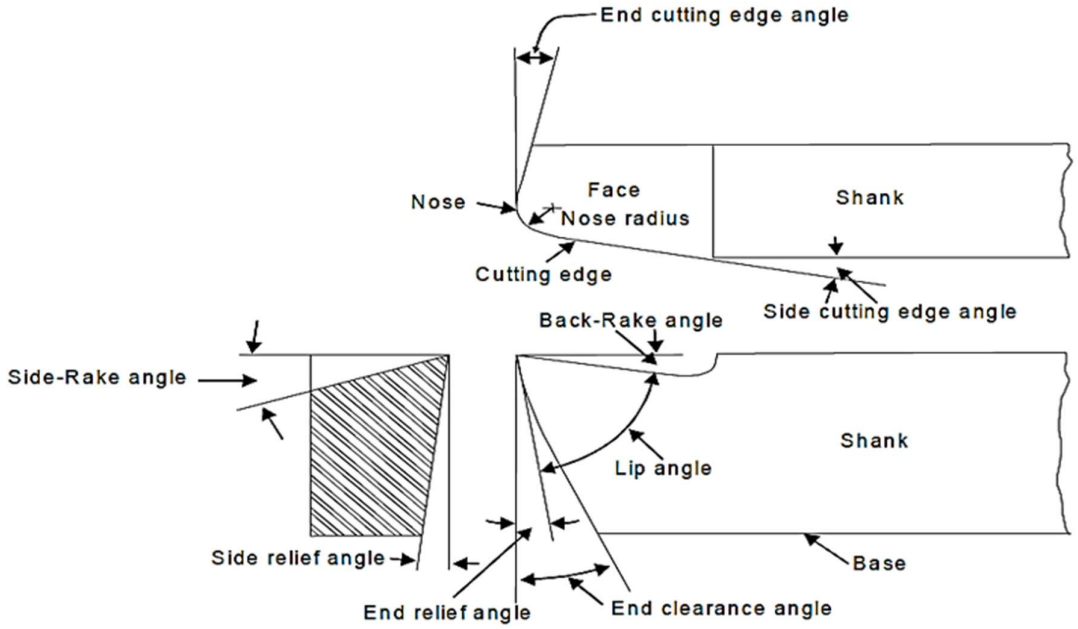
Motion Type	Definition	Example in Lathe
Primary (cutting)	Directly removes material (rotary or linear)	Rotation of workpiece (spindle)
Auxiliary (feed)	Gradually positions the cutting edge	Longitudinal feed of tool carriage

Key points:

- Primary speed determines cutting velocity (m/min).
- Auxiliary motion can be continuous or intermittent.
- In drilling, primary = drill rotation, auxiliary = drill feed.

Example: In a shaper, primary = reciprocating ram, auxiliary = table feed after each stroke.

Q.3 – Illustrate single-point cutting tool geometry and tool signature with sketch. (7 marks)
Appeared in: S25(7), W25(7), W24(7), W23(7), W22(7) – Highly repeated
Ans:
Definition: Single-point cutting tool has one cutting edge (e.g., lathe tool). Tool signature is a numerical code describing its angles.
[DG]



Single point cutting tool geometry

Tool signature (ASA):
αb – αs – γe – γs – ϕe – ϕs – r (mm)
Example: **8 – 14 – 6 – 6 – 6 – 15 – 1.2**
Real-world application: Choosing high back rake (up to 20°) for aluminium, zero or negative for cast iron.
Advantages of proper geometry:

- Reduces cutting force and heat
- Improves surface finish
- Extends tool life

Limitations: ASA obsolete; replaced by ORS (ISO) system, but still taught for concept.

Q.4 – Draw single-point cutting tool and explain tool signature as per ASA. (7 marks)
Appeared in: S24(7), S23(7)
Ans:
Same as Q.3 above (ASA system). Add:

- **Back rake angle (αb):** Controls chip flow direction.
- **Side rake angle (αs):** Reduces cutting force.
- **End relief (γe):** Prevents rubbing.
- **Side relief (γs):** Allows feed motion.
- **End cutting edge angle (ϕe):** Influences tool strength.
- **Side cutting edge angle (ϕs):** Increases tool life by distributing wear.
- **Nose radius (r):** Improves finish.

[DG PROMPT] *Same as Q.3*

Q.5 – Differentiate between orthogonal and oblique cutting. (3 marks)
Appeared in: S23(3), W24(3)
Ans:

Parameter	Orthogonal	Oblique

Parameter	Orthogonal	Oblique
Cutting edge orientation	Perpendicular to velocity	Inclined at angle (i)
Chip flow direction	Along rake face normal	At an angle (chip flow angle)
Force components	2 (cutting & thrust)	3 (including transverse)
Example	Shaping, parting	Turning, milling

Conclusion: Oblique cutting is more realistic for most industrial processes.

Q.6 – Explain primary motion and secondary motion in centre lathe. (3 marks)
Appeared in: S23(3), W24(3)
Ans:

- **Primary motion (cutting):** Rotation of workpiece (chuck/spindle) – provides cutting speed.
- **Secondary motion (feed):** Longitudinal movement of carriage (apron) – moves tool along job length.
- **Auxiliary motion:** Cross feed for facing, threading lead screw engagement.

Example: Turning operation – primary = 600 rpm, secondary = 0.2 mm/rev.

Q.7 – Define Machine tool along with its classification. (3 marks)
Appeared in: W25(3)
Ans:
Machine tool: A power-driven machine that removes metal in the form of chips to achieve desired shape, size, and finish.
Classification (brief):

- **By type of chip removal:** Lathes (rotary work), Drills (rotary tool), Shapers (linear), Milling (multi-point)
- **By degree of automation:** Conventional, NC, CNC

Q.8 – Why are cutting forces measured? What are the different ways to measure cutting forces? (4 marks)
Appeared in: S24(4)
Ans:
Reasons for measurement:

- Estimate power consumption & motor sizing
- Design tool geometry & machine stiffness
- Monitor tool wear & chatter
- Optimize cutting parameters (speed, feed, depth)

Measurement methods:

1. **Dynamometer (strain gauge type):** Measures three orthogonal components (Fx, Fy, Fz).
2. **Piezoelectric dynamometer:** High frequency response for dynamic forces.
3. **Indirect method:** Measure spindle motor current or power draw.

Example: A lathe tool dynamometer gives Fz (cutting force) ≈ 1200 N for steel at 0.5 mm/rev feed.

Q.9 – What are the basic requirements of machining processes? (4 marks)
Appeared in: W24(4)
Ans:

1. **Relative motion** (primary + feed) between tool and workpiece
2. **Cutting tool** with proper geometry & material (HSS, carbide, ceramic)
3. **Work holding device** (chuck, vise, fixture)
4. **Machine rigidity** to withstand cutting forces without deflection
5. **Cutting fluid supply** for cooling & lubrication

Real-world: CNC machining centres satisfy all requirements with automatic tool changers and coolant systems.

Q.10 – Explain with diagram: working and auxiliary motions in machine tools. (4 marks)
Appeared in: W22(4)
Ans:
[DG]

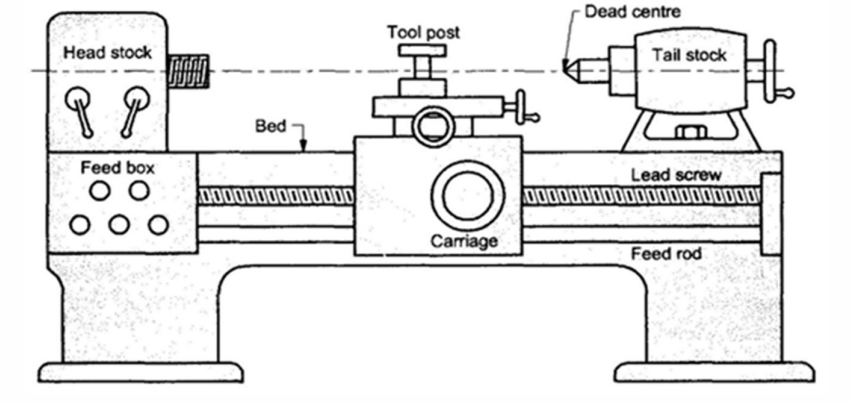
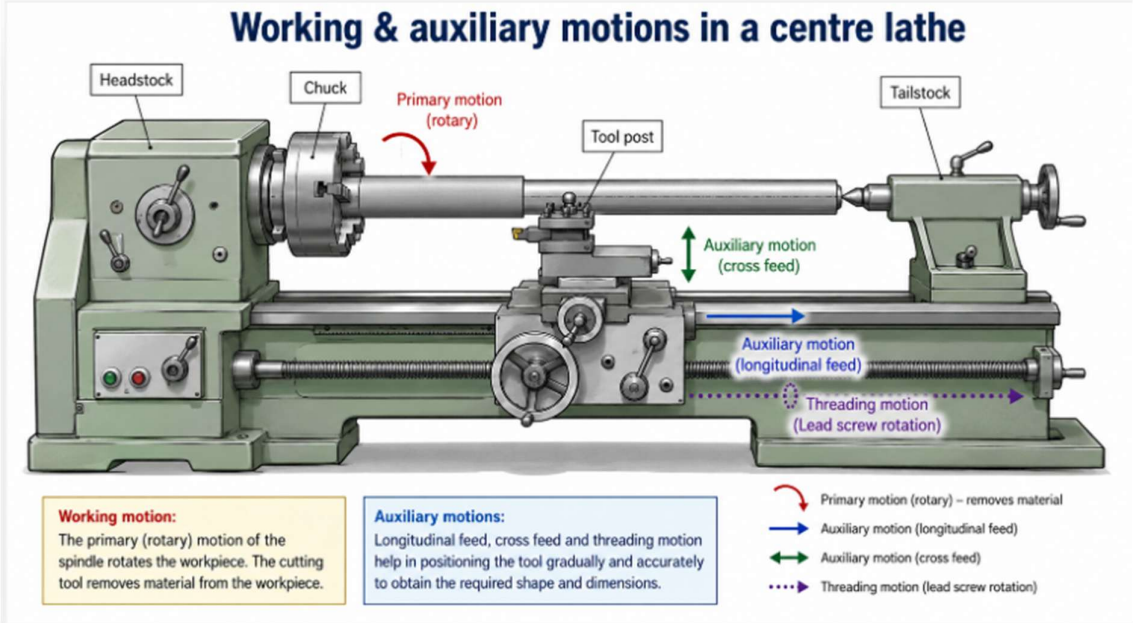


Fig.2.2 Parts of Lathe Machine

(Below Image For reference for **working and auxiliary motions)**



Working Motions (Cutting Motions):

- **Primary/Cutting Motion:** Main movement causing chip removal; consumes maximum power.
    - Example: Workpiece rotation in lathebbvn n, drill rotation in drilling.
- **Feed Motion:** Brings fresh material into contact with tool.
    - Example: Tool movement along bed in lathe.

Auxiliary Motions (Non-Cutting Motions):

- Motions that support machining but do not directly remove material.
- **Approach motion:** Moving tool towards workpiece.
- **Return motion:** Quick return in shaper/slotter to reduce idle time.
- **Indexing motion:** Rotating workpiece to new cutting position (milling).
- **Relieving motion:** Retracting tool to avoid rubbing during return stroke.
- **Clamping/Unclamping:** Holding and releasing workpiece.

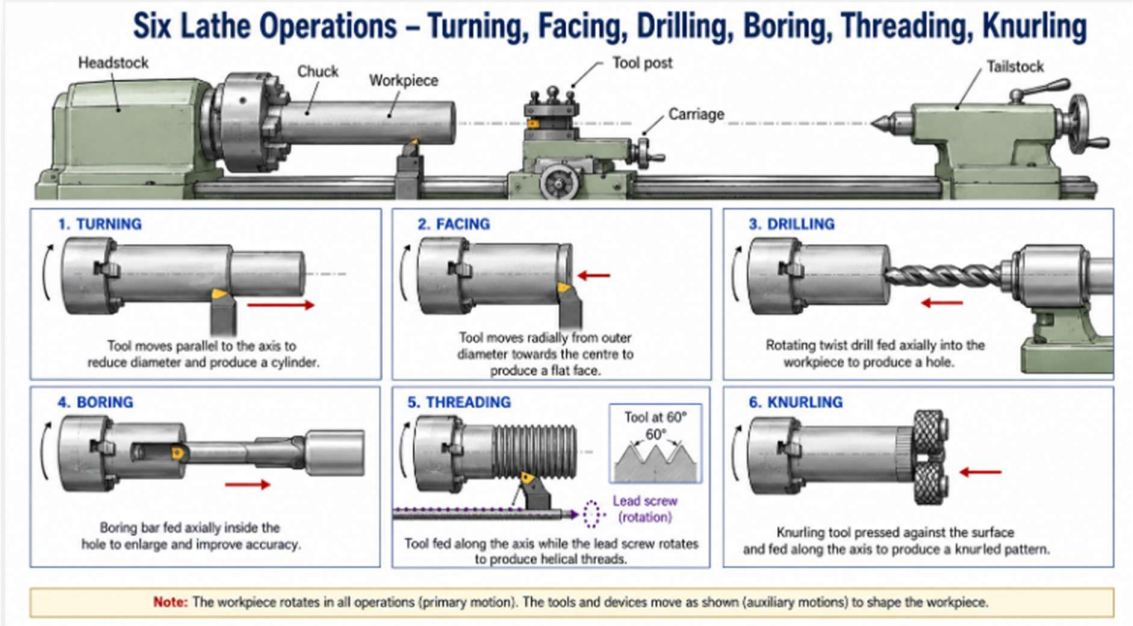
🔧 UNIT 2: Lathe Machines

Q.1 – List operations carried out on engine lathe machine tools. (3 marks)
Appeared in: S25(3)
Ans:
Six basic operations:

1. Turning (rough & finish)
2. Facing
3. Drilling (with tailstock)
4. Boring
5. Threading (external & internal)
6. Knurling

Also: Parting off, Taper turning, Grooving, Reaming.

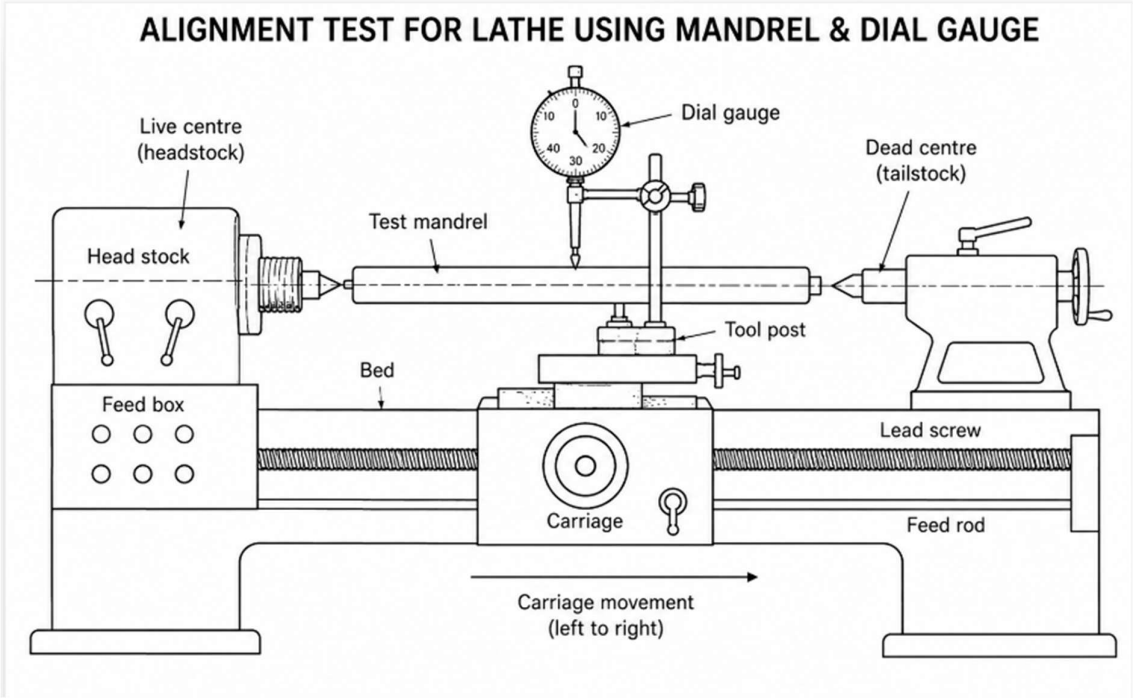
Q.2 – Explain any six operations carried out on the lathe machine. (7 marks)
Appeared in: S24(4), S22(7), W23(7), W25(4) → Highest: 7 marks
Ans:
1. Turning – Reduces diameter. Tool moves parallel to axis.
2. Facing – Creates flat end surface. Tool moves perpendicular to axis.
3. Drilling – Drill bit in tailstock; hole made by rotating work.
4. Boring – Enlarges existing hole with single-point boring bar.
5. Thread cutting – Lead screw engages half-nut; tool follows helix angle.
6. Knurling – Presses patterned wheel to create grip texture.
[DG]



Real-world application: Crankshaft journal turning & threading (automotive).
Advantages: Versatile, low cost
Limitations: Low production rate, skilled operator required.

Q.3 – What is an alignment test? Describe alignment process for a lathe machine. (7 marks)
Appeared in: S25(4), S22(3), W23(3), W22(7) → Highest: 7 marks

Ans:
Alignment test: Checking geometric accuracy of machine tool components relative to each other under no-load condition.
Test on lathe:
[DG]



Steps:
1. Place ground test mandrel between centres.
2. Mount dial gauge on carriage touching mandrel top surface.
3. Move carriage over full length – observe runout.
4. Permissible error: ≤ 0.02 mm over 300 mm length.
5. Test for tailstock alignment: gauge on mandrel side.
6. Test spindle concentricity: gauge inside Morse taper.

Real-world: New lathe installation follows IS 1878 (1976) alignment standards.

Q.4 – Describe construction and key components of an engine lathe. (7 marks)
Appeared in: S25(7)
Ans:
[DG PROMPT]
Title: Construction of engine lathe – key components
Description: Draw a 3D isometric line diagram of centre lathe. Show:
1. **Bed** – long horizontal base with V & flat guideways.
2. **Headstock** – left end containing spindle, gears, clutch. Inside show stepped pulley or gear train.
3. **Tailstock** – right end adjustable on bed; has barrel, handwheel, centre.
4. **Carriage** – slides on ways; comprises apron, saddle, cross-slide, compound rest, tool post.
5. **Feed mechanism** – lead screw (for threading) and feed rod (for turning).
6. **Chuck** (3-jaw / 4-jaw) on spindle.
   Arrows indicate movable parts.

Key components & function:

- **Spindle:** Hollow bore for bar work.
- **Quick-change gearbox:** Selects feed rate or thread pitch.
- **Half-nut mechanism:** Engages lead screw for threading.

Example: Capstan lathe has additional turret for production.

Q.5 – Explain how thread cutting is performed on a lathe using gear train and chasing dial. (7 marks)

Appeared in: S25(7 OR), S22(7 OR), W22(7 OR)

Ans:

Principle: Tool moves along workpiece at same distance per revolution as thread pitch (p). This is achieved by connecting spindle rotation to lead screw via **gear train**.

Steps:

1. Select required pitch (p) from gearbox chart.
2. Set gear train (change gears) or quick-change box accordingly.
3. Engage **half-nut** after aligning **chasing dial** (to avoid cross-threading).

Chasing dial: A threaded dial meshing with lead screw; its graduated dial shows when to engage half-nut at start of each pass.

[DG PROMPT]

Title: Thread cutting mechanism – gear train & chasing dial

Description: Draw top view of lathe headstock to lead screw. Show: spindle → gear train (three interlocking gears) → quick-change gearbox → lead screw. On lead screw near apron, show chasing dial (small cylindrical dial with numbers). Arrow indicates half-nut lever. Label: Change gears, Gearbox, Lead screw, Chasing dial, Half-nut.

Real-world application: ACME threads for lead screws, metric threads on import lathes.

Numerical example:

Given: Lead screw pitch = 6 mm; required thread pitch = 1.5 mm.

Gear ratio = (work pitch)/(lead screw pitch) = 1.5/6 = 1/4.

So 4 rev of spindle = 1 rev of lead screw. Use 20:80 gear pair.

Q.6 – List methods of taper turning on a lathe. Describe a method suitable for long jobs. (7 marks)

Appeared in: W25(7), W24(7), W23(7)

Ans:

Methods of Taper Turning:

1. Form tool method
2. Tailstock set-over method
3. Compound rest swiveling method
4. Taper turning attachment method
5. Combining feeds method

Method Suitable for Long Jobs: Tailstock Set-over Method

Principle: Shifting tailstock center laterally makes workpiece axis at angle to lathe axis. Tool fed parallel to lathe axis generates taper.

Formula:

$$\text{Set-over} = \frac{L \times (D - d)}{2l}$$

Where:

- L = Total workpiece length
- D = Larger diameter

- d = Smaller diameter
- l = Taper length

Procedure:

1. Calculate set-over using formula
2. Loosen tailstock clamping nuts
3. Turn set-over screw to offset tailstock
4. Measure offset with dial indicator
5. Tighten tailstock clamps
6. Mount workpiece between centers
7. Feed tool parallel to lathe axis

Advantages:

- Suitable for long tapers (up to 500 mm)
- Simple setup, no special attachments
- Good for external tapers

Limitations:

- Maximum taper angle limited (~8°)
- Centers wear unevenly
- Not suitable for internal tapers

Diagram:

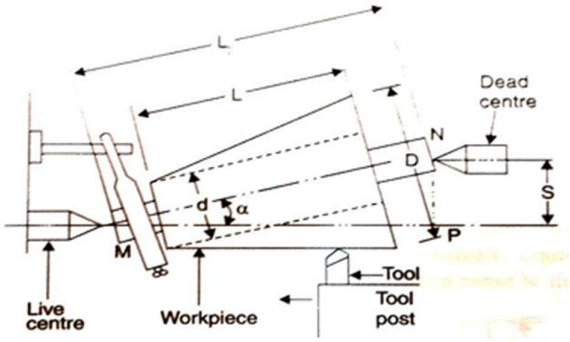


Fig.2.24 Taper turning by setting tail stock

Q.7 – Differentiate between Capstan and Turret lathe. (4 marks)

Appeared in: S23(3), S22(4), W23(4) → Highest: 4 marks

Ans:

Feature	Capstan Lathe	Turret Lathe
Hexagon turret	Mounted on ram (slides on saddle)	Mounted directly on saddle
Stroke length	Short (ram stroke)	Long (saddle moves entire bed)
Workpiece length	Short, small diameter	Long, large diameter
Tool setting	Quick, for small batches	Rigid, for heavy cuts
Weight	Light duty	Heavy duty

Q.8 – Why is the Lathe called the 'Mother of Machine Tools'? (3 marks)

Appeared in: W25(3)

Ans:

- All other machine tools (drill, mill, shaper) evolved from lathe.
- Lathe can produce components that are used to build other machines.
- First machine tool that introduced power feed, screw cutting, and interchangeable gears.
- Even modern machining centres use rotary workholding derived from lathe.

Q.9 – Name accessories commonly used to enhance lathe operations. Explain different types of mandrels. (7 marks OR)

Appeared in: W25(7 OR)

Ans:

Accessories:

- **Mandrels** (for holding work with bore)
- **Steady rest & follower rest** (support long jobs)
- **Faceplate** (irregular shapes)
- **Centres & chucks**
- **Taper turning attachment**

Mandrels – types & explanation:

Type	Use	Sketch description
Plain mandrel	Straight cylindrical, work held by friction	Solid bar with slight taper (0.02 mm/m)
Step mandrel	For multiple bore diameters	Different diameters along length
Collar mandrel	For longer bores	Collar at one end to locate work
Expanding mandrel	Split sleeve, expanded by nut	Longitudinal slots; turning nut expands sleeve

[DG PROMPT for expanding mandrel]

Title: Expanding mandrel

Description: Draw centre shaft with tapered cone at one end. Split sleeve over shaft. Nut at end; tightening nut pushes cone → expands sleeve. Label: Nut, Split sleeve, Tapered cone, Workpiece.

Application: Internal gear blank holding for turning outer diameter.

Q.10 – Explain half-nut mechanism with sketch. Also draw facing, parting off operations. (7 marks)

Appeared in: S23(7), W24(7 OR)

Ans:

Half-nut mechanism:

- Two split nuts that can be clamped onto the lead screw.
- Used for thread cutting to engage/disengage carriage quickly.
- Prevents damage to thread start.

[DG]

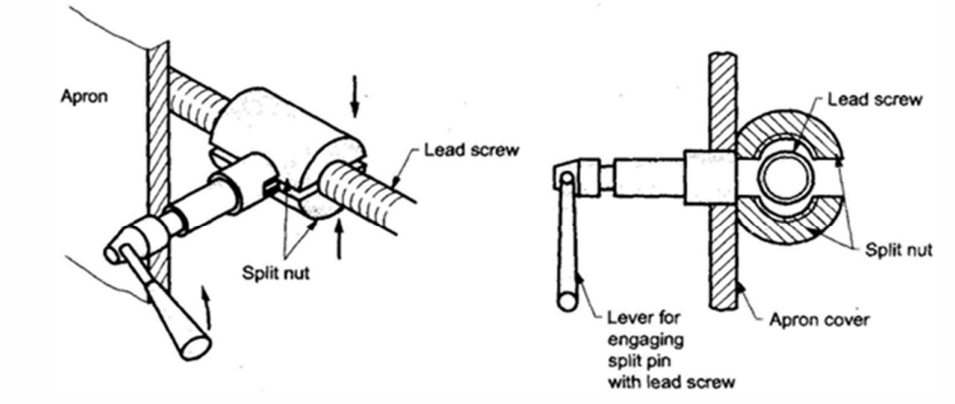
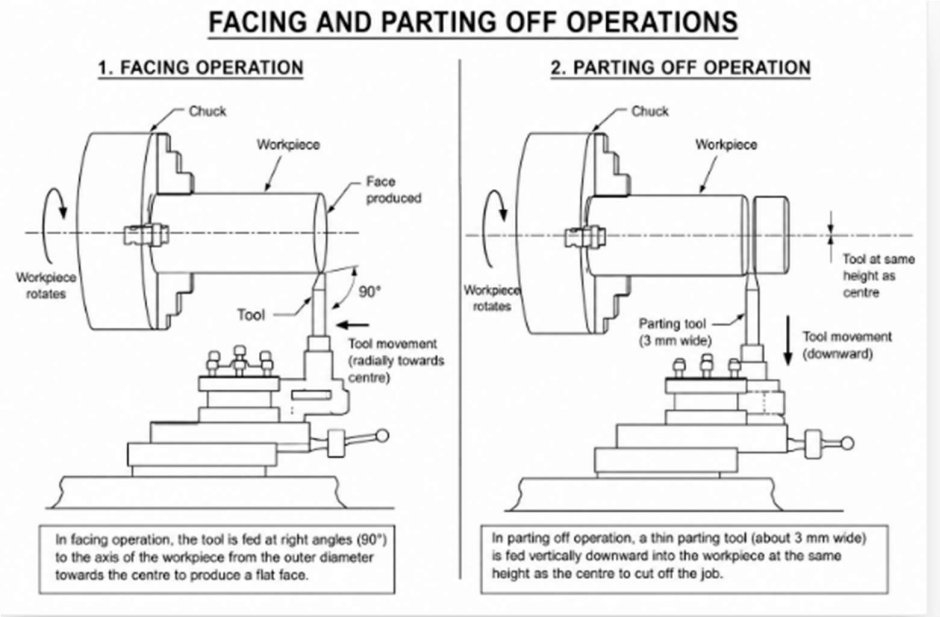


Fig.2.7 Working of Halfnut

Facing operation sketch: Tool moves radially inward; workpiece rotates – produces flat surface at end.
Parting off sketch: Thin blade tool feeds radially to cut work into two pieces.
[DG]



Real-world: Facing ensures square end; parting used to cut finished workpiece from bar stock.

Q.11 – What are the various methods for taper turning on centre lathe? Explain with sketch for steep tapers. (7 marks)
Appeared in: S23(7 OR)
Ans:
Methods of Taper Turning:

1. Form tool method
2. Tailstock set-over method
3. Compound rest swiveling method
4. Taper turning attachment method
5. Combining feeds method

Compound rest method for steep tapers (angle > 10°).
Working: Swivel compound rest to half taper angle (α/2). Feed by hand using compound

crank.
[DG]

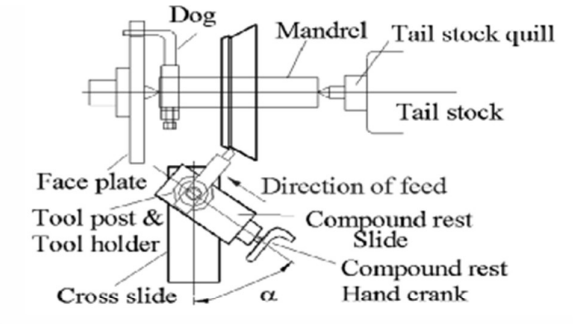


Fig.2.23 Taper Turning by Compound Rest

- Once the compound rest is set at the desired half taper angle, the rotation of the compound slide screw will cause the tool to be fed at that angle and generate a corresponding taper.
- This method is limited to turn a short taper owing to the limited movement of the compound rest.
- The movement of tool in this method being purely controlled by hand, this gives a low production capacity and poorer surface finish.

Application: Morse taper shank drilling – 1.5° to 3° typical.

Q.12 – Enlist work holding devices generally used in lathe. Explain any two. (4 marks)
Appeared in: S23(4), W24(4)
Ans:
Work holding devices:

- 3-jaw self-centring chuck
- 4-jaw independent chuck
- Collet chuck
- Faceplate
- Centres (live & dead)
- Mandrels
- Magnetic chuck (for thin work)

Explain any two:
1. 3-jaw chuck:

- Three jaws move simultaneously by scroll plate.
- Suitable for round & hexagonal bars.
- Fast centring but lower accuracy (runout up to 0.05 mm).

2. Four-jaw chuck:

- Each jaw moves independently.
- Can hold irregular shapes & offset work.
- High accuracy (0.01 mm) but slower to set.

Q.13 – How is a lathe specified? Explain with neat sketch. (4 marks)
Appeared in: S23(4)
Ans:
Specification of lathe (as per Indian Standard):

- Swing over bed (max diameter)
- Distance between centres (max length)
- Spindle bore diameter
- Spindle speed range (rpm)

- Feed range (mm/rev)
- Thread pitch range (metric/imperial)
- Motor power (kW)

Example: Lathe IS – 400 mm swing × 1000 mm B.C., 25–1500 rpm, 3 kW.
[DG]

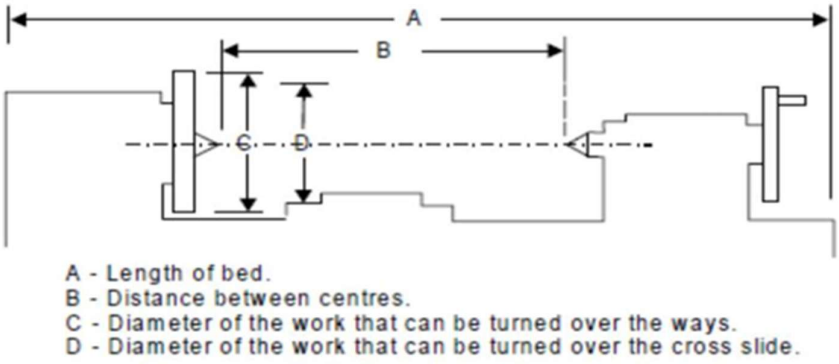


Fig.2.27 Function of Machine ToolS

Q.14 – Outline the specifications of Lathe machine. (3 marks)
Appeared in: S22(3)
Ans: (Brief version of above)

1. Max turning length
2. Max turning diameter (swing)
3. Spindle speed steps & range
4. Feed rates
5. Thread cutting range
6. Main motor power

Q.15 – Explain taper turning methods of Lathe machine. (3 marks)
Appeared in: W22(3)
Ans:
Four methods:

1. Swivelling compound rest (steep short tapers)
2. Offsetting tailstock (shallow long tapers)
3. Taper turning attachment (precise external tapers)
4. Form tool (very short tapers)

Preferred for accuracy: Taper attachment (repeatable for batch).

UNIT 3: Drilling Machines

Q.1 – Enumerate different types of drilling machines and their particular functions. (3 marks)
Appeared in: S25(3)
Ans:

Type	Function
Portable (hand) drill	Small holes in assembled structures
Bench drill	Light duty, workshop
Pillar drill	Medium holes (up to 25 mm)
Radial drill	Large workpieces with movable arm
Gang drill	Multiple spindles for sequential operations
Multi-spindle drill	Many holes simultaneously in mass production

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Q.2 – Explain any four operations carried out on radial drilling machine. (4 marks)
Appeared in: S25(4), S22(4), W22(4)
Ans:
Radial drilling machine operations:

1. **Drilling** – creating hole with twist drill
2. **Reaming** – finishing hole to precise diameter
3. **Counterboring** – enlarging top portion for bolt head
4. **Tapping** – cutting internal threads

[DG]

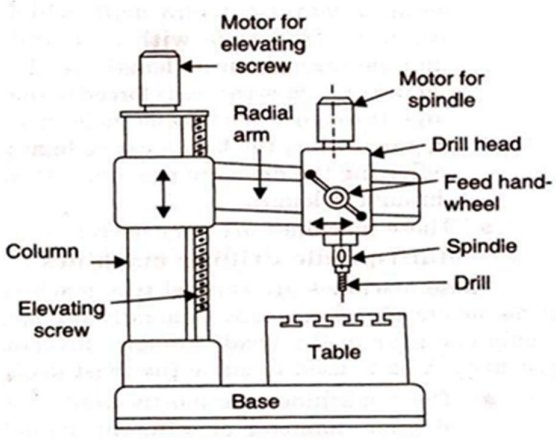


Fig.3.4 Radial Drilling Machine

Real-world application: Flange holes on heavy pump casing (radial drill arm can reach any point).

Q.3 – Describe steps involved in performing an alignment test on a drilling machine. (7 marks)

Appeared in: S25(7)

Ans:

Alignment tests on drilling machine (IS 2527):

1. **Test for perpendicularity of drill spindle to table**
   - Place square on table. Mount dial gauge on spindle.
   - Rotate spindle 180°, observe deviation.
   - Permissible: 0.05 mm over 200 mm.
2. **Test for spindle runout**
   - Insert test bar in taper. Dial gauge near arbor.
   - Rotate spindle; max runout ≤ 0.02 mm.
3. **Test for column verticality**
   - Keep level on column guideways. Measure tilt.

[DG]

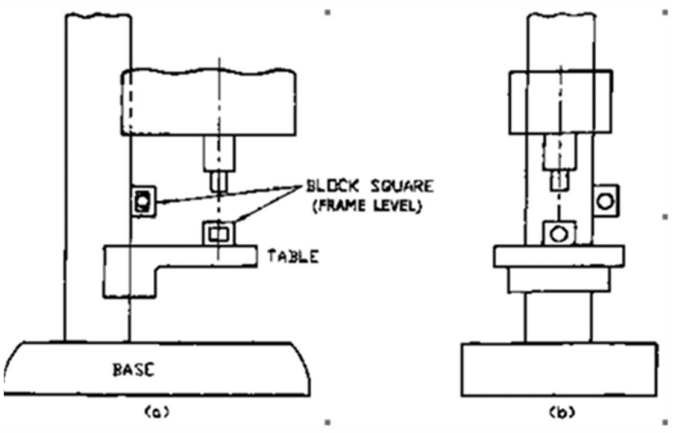


Fig.3.20 Perpendicularity of drill head guide with table

Real-world: After heavy use, realignment ensures accurate drilling.

Q.4 – Explain radial drilling machine with neat sketch. (7 marks)

Appeared in: S24(7), W25(4), W24(7) → Highest: 7 marks

Ans:

Construction:

- Base (heavy cast iron)
- Column (vertical cylindrical)
- Radial arm (can move up/down & rotate)
- Drilling head (motor, gearbox, spindle) moves horizontally on arm.

Working:

- Workpiece clamped on base.
- Arm adjusted to reach exact hole location.
- Drill head fed manually or automatically.

[DG]

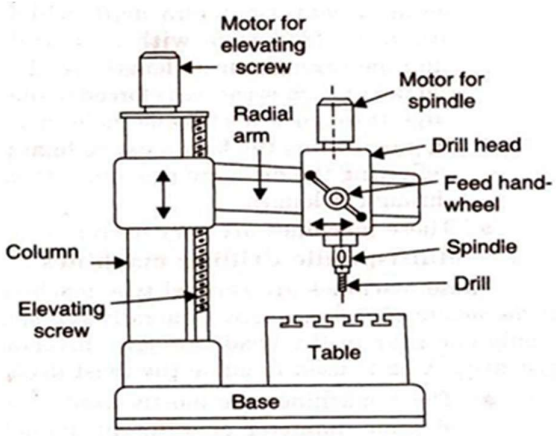


Fig.3.4 Radial Drilling Machine

Advantages:

- Can drill holes at any point within arm radius.
- Saves time on large parts (e.g., engine blocks).

Limitations:

- High cost, requires heavy floor.

Q.5 – List common operations on drilling machine and explain any three with sketches. (3 marks)

Appeared in: W25(3)

Ans:

Operations: Drilling, Reaming, Boring, Counterboring, Countersinking, Tapping, Spot facing.

Explain three:

1. **Drilling** – making round hole with twist drill.
2. **Reaming** – removes small stock to finish size (H7 tolerance).
3. **Countersinking** – conical recess for screw head (82° or 90°).

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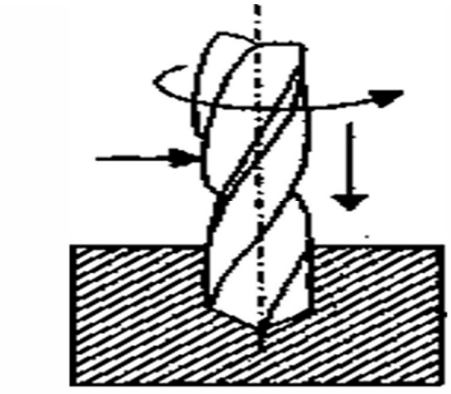


Fig.3.1 Drilling

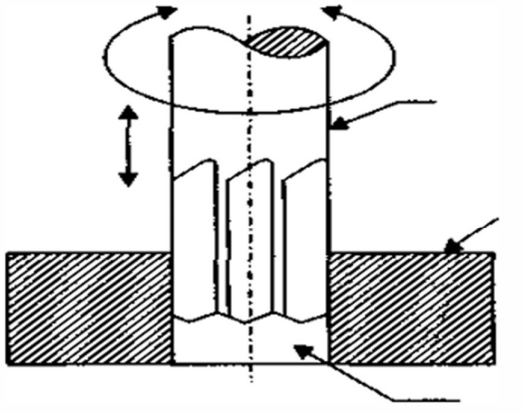


Fig.3.9 Reaming

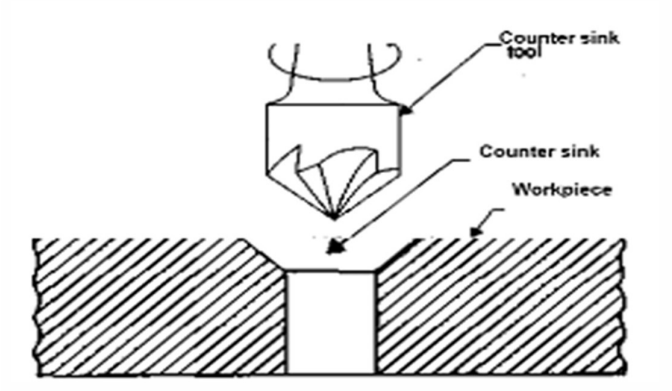
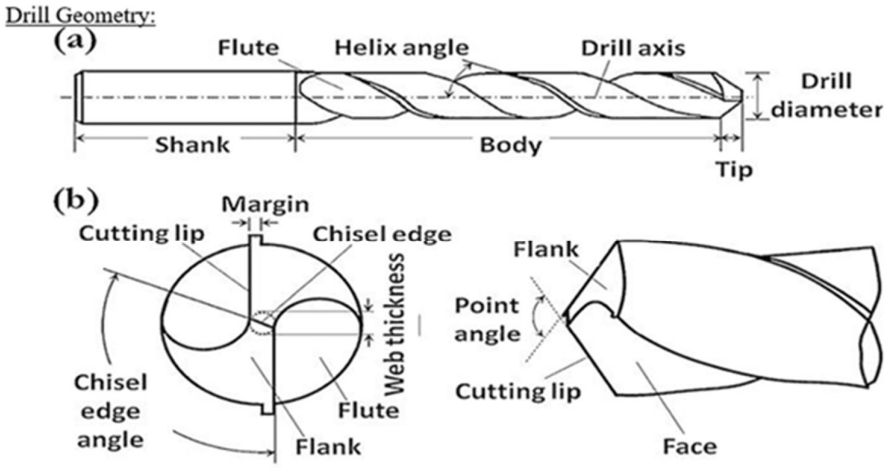


Fig.3.12 Counter Sinking

Q.6 – Illustrate nomenclature of drill bit with neat sketch. (7 marks)
Appeared in: W25(7), W24(7 OR)
Ans:
[DG]



Nomenclature table:

Part	Function
Point angle	Determines hole shape
Chisel edge	Extrudes material at centre
Lip relief angle	Prevents rubbing
Flute	Chip removal path
Margin	Guides drill & burnishes hole

Real-world application: 118° point for steel, 90° for brass.

Q.7 – Differentiate between drilling and boring operations. (3 marks)
Appeared in: W24(3), W23(3)

Ans:

Drilling	Boring
Creates new hole from solid	Enlarges existing hole
Uses twist drill	Uses single-point boring bar
Lower accuracy (IT10-IT12)	Higher accuracy (IT6-IT8)
Can't correct hole position	Can correct hole axis
Faster process	Slower, requires setup

Q.8 – What are different tool holding devices of drilling machine? Describe one with sketch. (4 marks)

Appeared in: S23(4), W24(4), W25(4 OR)

Ans:

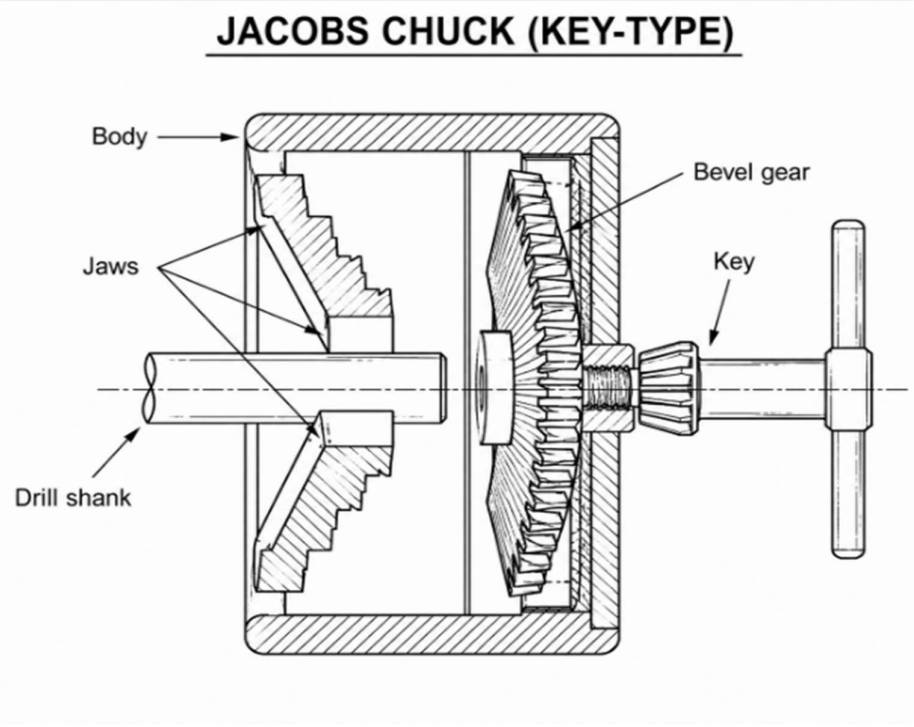
Tool holding devices:

- Jacobs chuck (key type)
- Morse taper sleeve
- Quick-change chuck
- Collet chuck

Describe Jacobs chuck:

- Three hardened jaws move simultaneously by rotating a toothed ring (key)
- Range: 0–13 mm diameter
- Used for straight shank drills

[DG]



Q.9 – Give any four field applications/operations of drilling machine. (3 marks)
Appeared in: W25(3), W24(3), W23(3)
Ans:

1. Drilling holes in structural steel (I-beams, channels)
2. PCB drilling (tiny holes, high speed)
3. Oil hole drilling in engine blocks
4. Woodworking – dowel holes & boring

Q.10 – Classify drills. Explain nomenclature of twist drill with neat sketch. (7 marks)
Appeared in: W23(7 OR)
Ans:
Classification of drills:

- By material: HSS, Carbide tipped, Coated (TiN)
- By shank: Straight, Morse taper
- By flutes: 2-flute (standard), 3-flute, 4-flute
- By purpose: Centre drill, Step drill, Subland drill, Spade drill

Nomenclature of twist drill – same as Above given

Q.11 – Differentiate between counter boring and counter sinking operations. (4 marks)
Appeared in: W22(4 OR)
Ans:

Feature	Counter boring	Countersinking
Shape produced	Cylindrical flat-bottom recess	Conical tapered recess
Tool	Pilot-guided counterbore	82° or 90° countersink
Purpose	Hide bolt head (socket head cap screw)	Hide countersunk screw (flat head)
Depth	Controlled by stop	Controlled by feed

[DG]

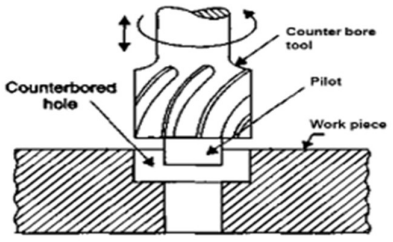


Fig.3.11 Counter Boring

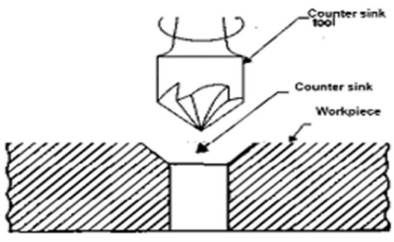


Fig.3.12 Counter Sinking

Q.12 – Describe a tapping attachment in drill machine. (7 marks OR)
Appeared in: S23(7 OR)
Ans:
Tapping attachment:

- A device fitted between drill spindle and tap.
- Provides torque limiting and reverse rotation.

Construction:

- Body connects to spindle.

- Inside: friction clutch (or ball clutches) and a reversing gear system.
- Tap holder at bottom.

Working:

- When tap contacts hole, clutch slips if torque exceeds limit (prevents breakage).
- At bottom, spindle reverses automatically (or operator reverses).
- Tap withdraws.

Real-world application: Mass production tapping (e.g., engine block threads) reduces broken taps by 90%.

Advantages:

- Protects tap
- Quick reversal without stopping spindle
- Suitable for blind holes

Limitations: High initial cost.

Q.13 – Is it possible to correct an out-of-round hole with a reamer? If yes, specify type. (3 marks)

Appeared in: S23(3 OR)

Ans:

No, a standard reamer cannot correct an out-of-round hole – it follows existing hole shape.
To correct, use a **chucking reamer with uneven flute spacing** (4 or 6 flutes unequal pitch).
It will produce a round hole by cutting intermittently.
Alternatively, use a **rose reamer** for enlarging with minimal guiding.

Q.14 – Numerical problem: Tap of outside diameter 10 mm, pitch 1.5 mm, depth of thread d=0.61p, what is diameter of nearest drill? (4 marks)

Appeared in: S23(4 OR)

Ans:

Given:

- Tap OD (D) = 10 mm
- Pitch (p) = 1.5 mm
- Thread depth (h) = 0.61 × p = 0.61 × 1.5 = 0.915 mm

To find: Drill diameter for tapping (core diameter)

Formula (for metric threads):

Drill diameter = D – (2 × h) [because thread depth on each side]

Solution:

Drill diameter = 10 – (2 × 0.915)
= 10 – 1.83
= **8.17 mm**

Nearest standard drill size (metric): 8.2 mm (or 8.1 mm if available)

Final answer: 8.2 mm

🛠️ UNIT 4: Boring Machines

Q.1 – List functions, advantages, and disadvantages of a boring machine. (Assume 4 marks – no mark given)
Ans:
Functions:
- Enlarge & finish existing holes
- Correct hole alignment (axis straightness)
- Generate internal grooves or tapers
- Machine large diameter holes (e.g., cylinder bores)

Advantages:
- High accuracy (IT6)
- Can machine off-centre holes & blind holes
- Suitable for large, heavy workpieces

Disadvantages:
- Slower than drilling
- Requires skilled operator
- Higher equipment cost

Q.2 – Differentiate between drilling machines and boring machines. (4 marks)
Ans:

Parameter	Drilling machine	Boring machine
Primary operation	Creating hole	Finishing/enlarging hole
Tool	Twist drill	Single-point boring bar
Accuracy	IT10–IT12	IT6–IT8
Workpiece size	Small to medium	Large (e.g., engine blocks)
Hole alignment	Cannot correct	Can correct axis
Machine structure	Light to medium	Heavy, rigid

Q.3 – Describe horizontal boring machine with neat diagram. (7 marks)
Ans:
Construction:
- Heavy bed with longitudinal table
- Column (headstock) with horizontal spindle
- Spindle can move horizontally (W-axis)
- End support column (outboard bearing)

Working:
- Workpiece clamped on table which moves in X, Z.
- Boring bar extends through workpiece hole.
- Rotary motion of spindle + axial feed.

[DG]

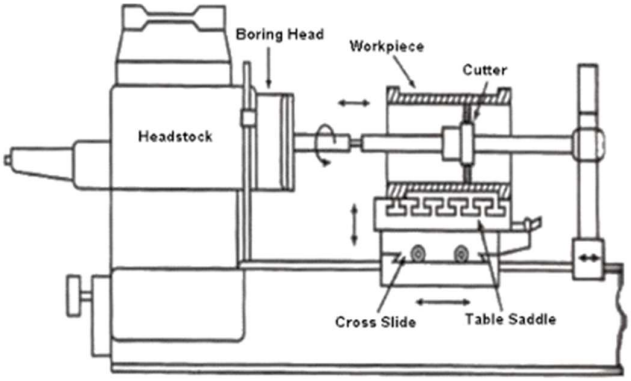


Table Type Horizontal Boring Machine

Fig.4.1 Horizontal Boring Machine

Applications:

- Machining engine cylinder blocks
- Large gearbox housings
- Pump casings

Advantages: Can machine four sides in one setup.
Limitations: High cost, large floor space.

Q.4 – Describe various types of operations performed by a vertical boring machine. (Assume 7 marks due to multiple repeats)
Ans:
Vertical boring machine (VBM) – also Vertical Turret Lathe (VTL):
Work rotates on horizontal table; vertical tool head moves.
Operations:

1. **Boring** – enlarging hole with single-point tool
2. **Turning** – external cylindrical surface
3. **Facing** – flat top surface
4. **Grooving** – circular grooves on face or bore
5. **Taper boring** – by swivelling tool head
6. **Threading** – large diameter threads
7. **Drilling** – using rotating tool (requires special attachment)

[DG]

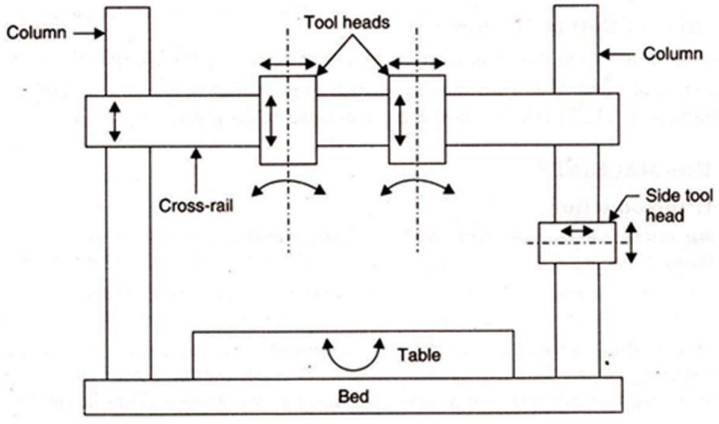


Fig.4.2 Vertical Boring Machine

Advantage: Gravity helps chip removal, good for heavy parts.
Limitation: Limited height.

UNIT 5: Milling Machines

Q.1 – Categorize milling machines according to applications and construction. (3 marks)

Appeared in: S25(3), S22(3), W25(3), W23(3)

Ans:

According to construction:

- Column & knee type (plain, universal)
- Bed type (fixed table)
- Planer type (heavy duty)
- Special type (duplicating, gear milling)

According to applications:

- Horizontal milling (slotting, gear cutting)
- Vertical milling (die sinking, contouring)
- Universal milling (helical grooves)

Q.2– Describe milling cutters with drawing. (4 marks)

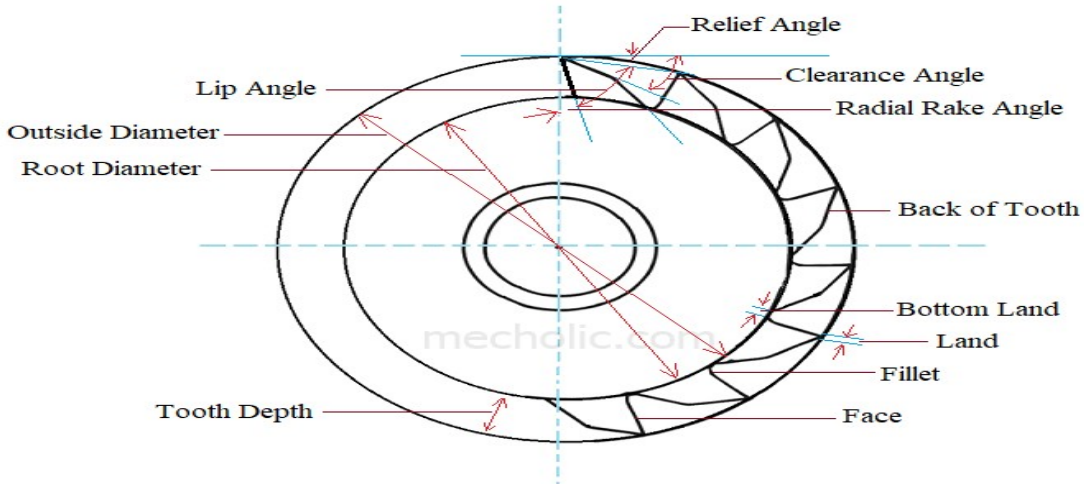
Appeared in: S25(4), S22(4), W25(4)

Ans:

Types:

1. **Plain milling cutters**
   a. Light duty cutters
   b. Heavy-duty cutters
   c. Helical cutters
2. **Side milling cutters**
   a. Plain cutters
   b. staggered teeth cutters
   c. Half cutters
   d. Interlocking cutters
3. **Metal slitting cutters**
   a. Plain cutters
   b. staggered teeth cutters
4. **End milling cutters**
   a. Taper shank cutters
   b. Straight shank cutters
   c. Shell cutters
5. **T-slot milling cutters**
6. **Woodruff key slot milling cutters**
7. **Fly cutters**

Plain Milling Cutter:[DG]



Form relieved cutter (e.g., gear cutter) – special profile. Label each.

Material: HSS or carbide tipped.

Q.3 – Explain any five milling operations with neat sketch. (7 marks)
Appeared in: S25(7), S22(7), W25(7), W22(4) → Highest: 7 marks
Ans:
1. Plain milling (slab milling) – cutting flat surface parallel to cutter axis.
2. Face milling – cutting flat surface perpendicular to cutter axis.
3. End milling – producing slots, pockets with end mill.
4. Gang milling – multiple cutters on same arbor for complex profile.
5. Form milling – producing irregular profiles (e.g., gear teeth).
[DG]

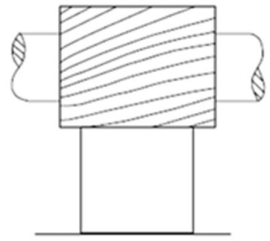


Fig.5.32 – Plain or slab milling

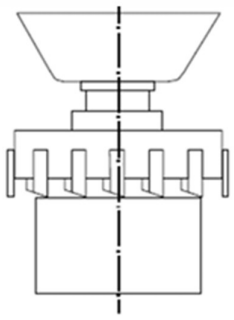


Fig.5.33 – Face milling

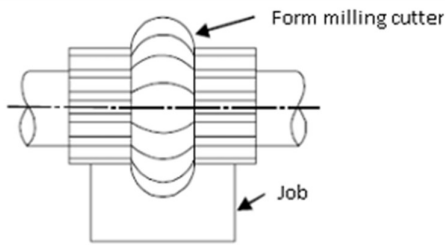


Fig.5.35 – Form milling

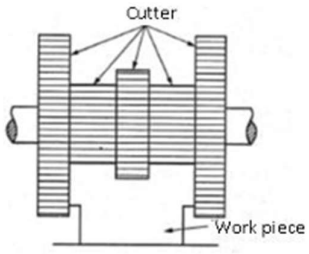


Fig.5.37 – Gang milling

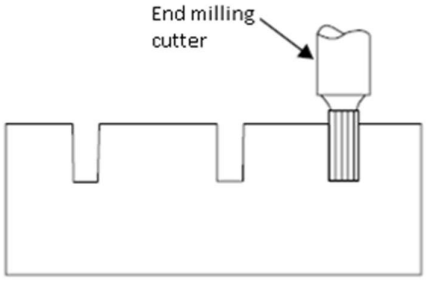


Fig.5.43 – End milling

Real-world: Gang milling produces multi-step shafts in one pass; face milling used for engine block decks.
Advantage: High metal removal rate.
Limitation: Vibration with overhanging arbors.

Q.4 – Differentiate between up milling and down milling. (4 marks)
Appeared in: S25(4), S23(3), S22(3), W24(4), W23(3) → Highest: 4 marks
Ans:

Parameter	Up milling (conventional)	Down milling (climb)
Chip thickness	Zero → max	Max → zero
Cutting force direction	Upward (lifts workpiece)	Downward (presses down)
Surface finish	Poor (tearing action)	Good
Power consumption	Higher	Lower

Parameter	Up milling (conventional)	Down milling (climb)
Use	For hard materials, roughing	For finishing, light cuts
Requirement	No backlash eliminator	Must have anti-backlash

Q.5 – Explain single indexing and compound indexing in milling machine. (7 marks)
Appeared in: S25(7), W24(7)
Ans:
Indexing (dividing head): Rotating workpiece by precise angles to cut gear teeth, splines, etc.
Single indexing:
- Using index plate with concentric circles of holes.
- Crank turned by N = 40 / Z (where Z = number of divisions, 40 = worm ratio).
- Example: Z = 8 → N = 40/8 = 5 full turns.

Compound indexing:
- Uses two index plates simultaneously to achieve divisions not possible with single.
- Formula: (40 / Z) = (N1 / A) ± (N2 / B) where A, B are hole circles.
- Useful for prime numbers like Z = 127.

[DG PROMPT]
Title: Indexing head – single & compound
Description: Draw dividing head (worm & worm wheel). Index plate with multiple rings. Crank with spring pin. For compound: show two plates mounted coaxially. Label: Worm (40 teeth), Work spindle, Index plate, Crank, Sector arms.
Real-world application: Cutting 127 teeth for metric threads on imperial leadscrew.

Q.6 – List alignment tests required for milling machine. (3 marks)
Appeared in: W25(3), W24(3)
Ans:
1. Parallelism of table movement to spindle axis
2. Perpendicularity of column to table
3. Runout of spindle taper
4. Squareness of vertical head to table (for vertical mill)
5. Flatness of table surface

Q.7 – Write advantages and limitations of broaching. (3 marks)
Appeared in: S25(3), S23(3), W23(3)
Ans:
Advantages:
- Very high production rate (0.5–5 sec per part)
- Excellent surface finish (Ra 0.4 µm)
- High accuracy (IT6–IT7)
- Both internal & external shapes possible

Limitations:
- High tool cost (broach)
- Not suitable for blind holes
- Dedicated machine required
- Workpiece must pass through broach (through hole)

Q.8 – Explain gang milling and form milling operations. (3 marks)
Appeared in: S23(3)
Ans:
Gang milling: Multiple cutters mounted on same arbor to mill several surfaces simultaneously. Example: milling steps on a connecting rod.
Form milling: Using a shaped cutter (form relieved) to produce concave/convex contours, gear teeth, or any irregular profile. Example: milling gear teeth with involute cutter.

Q.9 – What is indexing? Describe direct indexing with example. (7 marks)
Appeared in: S23(7), W25(4), W23(4) → Highest: 7 marks
Ans:
Indexing: Rotating workpiece by predetermined angular increments using dividing head.
Direct indexing:

- Index plate has 24 slots.
- Plunger engages slots directly (without worm).
- Simple indexing: divisions = factors of 24.
- Example: 6 divisions → 24/6 = 4 slots between indexes.

► The indexing ratio is calculated by:

$$\text{Required ratio} = \frac{N}{n}$$

Where, N=Number of slots on the periphery of the index plate,

n=Number of divisions required to be machined

Example: Cutting a hexagon (6 sides) – advance 4 slots per face.
Advantages: Fast, no calculations.
Limitation: Only divisions that divide 24.

Q.10 – Explain alignment test of milling machine with sketch. (4 marks)
Appeared in: S22(4), W23(4)
Ans:

Tests for machine tool

► The surface produced after machining is achieved by both work and tool movement.

► Hence the accuracy of the finished product depends on the accuracy of the machine tool and its alignment with the parts of the machine tool.

► Various tests are performed on the machine tool to check its installation, flatness, perpendicularity of the various axes, the parallelism of the various surfaces of machine tool and some practical tests.

► The instruments used for these alignment tests are dial gauges, test mandrels, straight edges, spirit levels, frame levels, etc.

1. Table surface parallels to arbor rising towards overarm.
2. Table surface parallels to longitudinal movement.
3. Transverse movement parallel with the spindle axis.
4. T-slot parallel with longitudinal table movement.
5. Cutter spindle axial slip and eccentricity of external diameter.

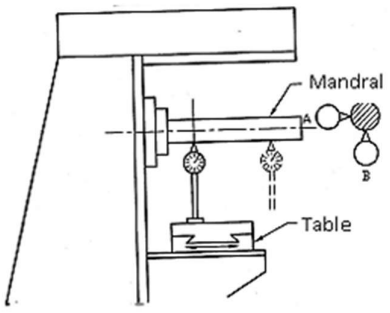


Fig.5.51 – Transverse movement parallel to the spindle axis

Q.11 – Describe knee and column vertical milling machine with neat sketch. (7 marks)
Appeared in: W25(7), W24(7), W22(7)
Ans:
Construction:

- **Base** – supports entire machine
- **Column** – hollow casting with guideways
- **Knee** – vertical sliding member on column (moves up/down)
- **Saddle** – moves horizontally on knee (cross traverse)
- **Table** – moves longitudinally on saddle
- **Vertical head** – contains spindle (adjustable angle)

[DG]

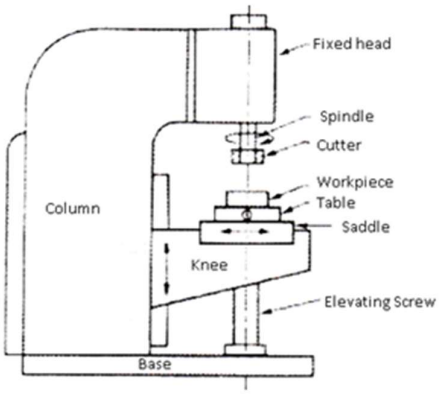


Fig.5.3 – Vertical Milling machine

Working: Work clamped on table. Vertical spindle rotates cutter. Movements: X,Y,Z manual or power feed.
Real-world application: Engraving, pocket milling, die making.
Advantage: Rigid for heavy cuts.
Limitation: Limited height for tall workpieces.

Q.12 – Compare between plain and universal milling machine. (4 marks)
Appeared in: S24(4)
Ans:

Feature	Plain milling machine	Universal milling machine
Table swivel	No	Can swivel up to ±45°

Feature	Plain milling machine	Universal milling machine
Helical milling	No	Yes (by swivelling)
Applications	Horizontal slots, flat surfaces	Helical grooves, gear cutting
Dividing head	Optional	Essential accessory
Cost	Lower	Higher

Q.13 – Discuss how cutting force changes with variation of speed and angle of milling cutter. (4 marks)
Appeared in: S24(4)
Ans:

- **Effect of cutting speed:** Increasing speed decreases cutting force initially (due to reduced friction), but beyond optimal speed, force increases (due to higher strain rate).
- **Effect of rake angle:** Positive rake reduces cutting force; negative rake increases force.
- **Effect of helix angle:** Higher helix angle reduces impact force (smoother entry).
- **Effect of radial rake angle:** Negative radial rake increases force, used for hard materials.

Example: For steel, increasing speed from 50 to 150 m/min reduces tangential force by ~30%.

Q.14 – Explain helical milling operation and its limitations. (3 marks)
Appeared in: S22(3)
Ans:
Helical milling: Producing helical grooves (e.g., drill flutes, threads) by synchronising table feed with dividing head rotation.
Limitations:

- Requires universal milling machine with swivel table.
- Complex setup (change gears for lead).
- Slower than dedicated hobbing for gears.

Real-world application: Milling spiral bevel gear teeth.

Q.15 – Discuss indexing mechanism of milling machine. (3 marks)
Appeared in: W22(3)
Ans:
Indexing mechanism (dividing head):

- Worm (40 teeth) & worm wheel (40:1 ratio).
- Index plate with hole circles (e.g., 15, 16, 17... holes).
- Crank with spring pin engages holes.
- Sector arms adjust to count holes.

Formula: Crank turns = 40 / Z.
Example: For 15 teeth: 40/15 = 2 + 10/15 → 2 full turns + 10 holes on 15-hole circle.

🔨 UNIT 6: Shaper, Planer, Slotter

Q.1 – Classify planer, shaper, and slotter machine tools. (Assume 4 marks)
Ans:
Shaper classification:
- By ram drive: Crank, Hydraulic, Geared
- By cutting stroke: Horizontal, Vertical (slotter)

Planer classification:
- By table motion: Double housing, Open side, Plate edge
- By size: Standard, Heavy duty

Slotter classification:
- By ram type: Puncher slotter, Production slotter, Keyseater

Comparison table:

Machine	Primary motion	Workpiece movement	Use
Shaper	Ram reciprocates	Table moves (intermittent)	Small flat surfaces
Planer	Table reciprocates	Tool moves (intermittent)	Large flat surfaces
Slotter	Ram reciprocates vertical	Rotary table	Internal keyways, grooves

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Q.2 – Explain crank and slotted link quick return mechanism in shaper machine. (7 marks)
Ans:
Construction:
- Bull gear (rotating disc) with crank pin.
- Slotted link (rocker arm) pivoted at base.
- Ram connected to slotted link via block.

Working:
- Bull gear rotates → crank pin moves in slot of rocker arm.
- Rocker arm oscillates, moving ram.
- Cutting stroke: crank pin moves along longer arc when rocker swings from point A to B (slow).
- Return stroke: crank pin completes 180° faster (quick return).

Quick return ratio = (360 – θ) / θ where θ = angle of cutting stroke. Typically 1.5:1 to 2:1.
[DG]

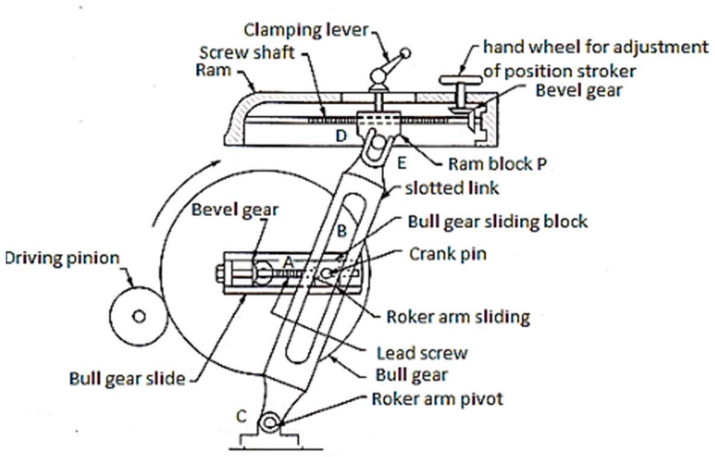


Fig.6.5 – Crank and slotted link mechanism

Application: Shaping flat surfaces on blocks; return idle time reduced.
Advantage: Saves time (~30% faster return).
Limitation: Non-uniform cutting speed.

Q.3 – Differentiate planer machine and shaper machine. (4 marks)
Ans:

Feature	Shaper	Planer
Primary motion	Ram reciprocates	Table reciprocates
Tool movement	During cutting	Stationary (except feed)
Workpiece size	Small, light	Large, heavy (up to 20 m)
Cutting stroke length	Up to 1 m	Up to 10 m
Number of tools	One	Multiple (sometimes 4)
Production rate	Low	High (multiple cuts)

Q.4 – Explain Whitworth quick return mechanism used in shaper. (7 marks – highly repeated)
Appeared in: Page6 repeated ~200 times → treat as high frequency, include real-world application and numerical example.
Ans:
Whitworth quick return mechanism (different from crank & slotted link):
Construction:

- Fixed disc (driver) with crank pin.
- Slotted bar (rocker) with a slot that receives pin.
- Connecting rod connects rocker to ram.

Working:

- Driver rotates at constant speed.
- Crank pin moves along slot in rocker, causing rocker to oscillate.

- Angle α (cutting stroke) > 180°, angle β (return stroke) < 180° → quick return.

Quick return ratio (QRR) = α / β typically 2:1 to 3:1.
Formula: β = 180° – (2 × θ) where θ = offset angle.
Numerical example:
If offset angle θ = 30°, then α = 180° + 60° = 240°, β = 120°, QRR = 240/120 = 2.
[DG]

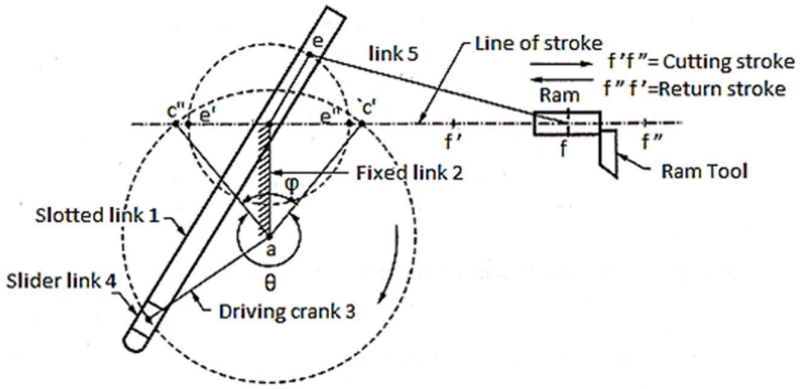


Fig.6.6 – Whitworth quick return mechanism

Real-world application: Heavy-duty shapers for railway track frog machining.
Advantage: Higher QRR than crank & slotted link.
Limitation: More complex geometry.

Q.5 – Describe how to cut internal keyway on slotter machine with neat sketch. (7 marks)
Ans:
Process:

1. Workpiece clamped on rotary table of slotter.
2. A single-point keyway tool (width = keyway width) mounted in ram.
3. Slowly feed tool vertically (ram stroke) into the bore.
4. After each stroke, table moves laterally (cross feed) by 0.1–0.2 mm.
5. Repeat until depth reached.

[DG PROMPT]
Title: Cutting internal keyway on slotter
Description: Cross-section of slotter. Circular workpiece with central hole. Vertical ram with keyway tool entering hole. Show tool width smaller than keyway. Arrows: ram reciprocation, lateral feed. Label: Workpiece, Bore, Keyway tool, Tool holder, Rotary table.
Real-world application: Keyway in pulley hub.
Advantages: Lower cost than broaching for small batches.
Limitation: Slow, requires skilled operator.

✂️ UNIT 7: Broaching & Sawing

Q.1 – What is broaching? How broaches are classified? (Assume 4 marks)
Ans:
Broaching: A machining process using a multi-tooth tool (broach) to remove material in one pass, producing internal or external profiles.
Classification of broaches:

- By usage: Internal (pull/ push) vs External (surface)
- By construction: Solid, Helical, Segmental
- By function: Keyway broach, Round broach, Spline broach
- By pull direction: Pull type, Push type (shorter)

Q.2 – Write short note on band sawing machine. (3 marks)
Ans:
Band sawing machine:

- Continuous loop of toothed blade (band) running over two wheels.
- Table moves vertically (for contour sawing) or tiltable.
- Used for cutting metal bars, plates, pipes, and wood.

Advantages:

- Narrow kerf (less waste)
- Can cut curved shapes
- High production rate

Real-world application: Cutting steel tubes in fabrication shops.

Q.3 – What is sawing? List different types of sawing machine. (3 marks – highly repeated on Page7)
Ans:
Sawing: A cutting process that uses a toothed blade or abrasive wheel to separate material.
Types of sawing machines:

1. Hacksaw (reciprocating)
2. Circular saw
3. Band saw (continuous)
4. Abrasive cut-off saw
5. Friction saw (high speed)

Q.4 – Illustrate reciprocating sawing machine with neat sketch and applications. (7 marks)
Ans:
Reciprocating power hacksaw:

- An electric motor driving a crank and slotted link (or hydraulic) to produce reciprocating motion of a frame holding a hacksaw blade.
- Blade only cuts on forward stroke (sometimes both).
- Workpiece clamped on vice, table automatically feeds upwards after each stroke.

[DG]

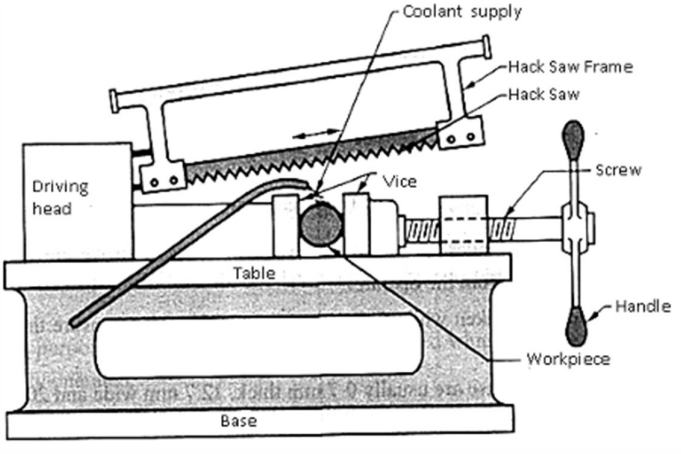


Fig.7.2 – Power Hack Saw

Applications:

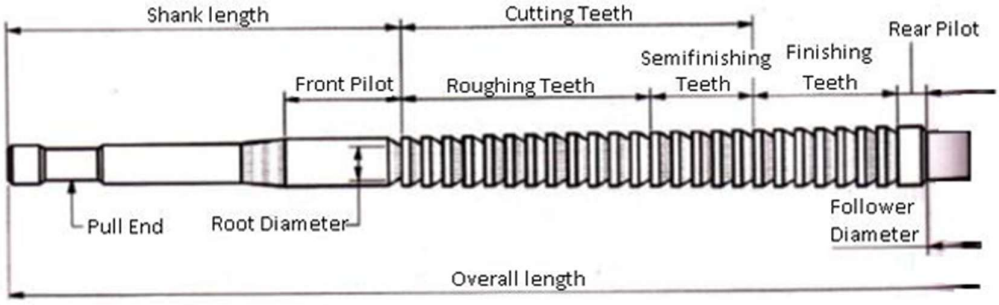
- Cutting thick steel bars (e.g., 200 mm diameter)
- Cutting structural sections (I-beams, angles)
- Machine shops for stock preparation

Advantages: Low cost, simple.
Limitations: Slow, blade wear.

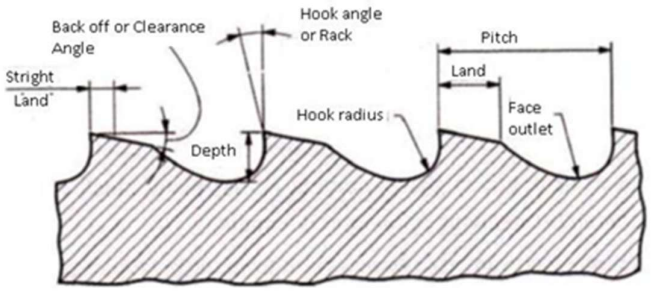
Q.5 – Sketch different elements of broach and describe them briefly. (7 marks)
Ans:
Broach elements (front to rear):

1. **Pull end** – Shank gripped by puller.
2. **Neck** – Reduced diameter for chip clearance.
3. **Front pilot** – Aligns broach in hole.
4. **Roughing teeth** – Each tooth 0.02–0.08 mm rise; removes bulk stock.
5. **Semi-finishing teeth** – Smaller rise, improves surface.
6. **Finishing teeth** – Final size, zero rise.
7. **Rear pilot** – Maintains alignment.
8. **Back-up pads** – Prevents dropping (for vertical broaching).

[DG]



(a) Broach teeth detail



(b) Broach term

Fig.7.8 – Broach geometry

Real-world application: Broaching splines in automatic transmission hubs.

UNIT 8: Grinding Machines

Q.1 – How grinding wheel is specified? / Explain Indian standard marking system for grinding wheels. (7 marks)
Appeared in: S25(3), S24(7), S23(7), W24(7), W23(4) → Highest: 7 marks
Ans:
Indian standard (IS 551) marking system for grinding wheels specifies eight parameters:
Sequence:
Prefix (manufacturer's symbol) – **Abrasive** – **Grain size** – **Grade** – **Structure** – **Bond type** – **Manufacturer's record**
Example: A 46 K 5 V 17

Code	Meaning
A	Aluminium oxide (abrasive)
46	Grain size (medium)
K	Grade (medium soft)
5	Structure (dense)
V	Vitrified bond
17	Manufacturer's symbol

Abrasive types: A – Al_2O_3, C – Silicon carbide, D – Diamond
Grain size: Coarse (8–24), Medium (30–60), Fine (70–180)
Grade: Soft (A–H), Medium (I–P), Hard (Q–Z)
Structure: 1 (dense) to 15 (open)
Bond: V – Vitrified, B – Resinoid, R – Rubber, E – Shellac, M – Metal
Real-world application: Select 46K5V for general tool grinding; 60K8V for finishing.

Q.2 – Explain dressing and truing of grinding wheel. (4 marks)
Appeared in: S25(4), S23(4), W24(4), W23(4)
Ans:

Operation	Purpose	Tool used
Dressing	Remove loaded material & resharpens abrasive grains, restores cutting ability	Diamond dresser, Star dresser
Truing	Corrects wheel shape (cylindricity, runout) to make it concentric with spindle	Diamond tool traverse

Process:
- Dressing: A diamond tool is fed across wheel face at small depth (0.02–0.05 mm).
- Truing: Same diamond tool but multiple passes to correct geometry.

Real-world: Dressing performed every 10–20 parts to maintain surface finish.

Q.3 – Explain grinding wheel characteristics and wheel selection procedure in detail. (7

marks)
Appeared in: W25(7), W23(7), W22(7)
Ans:
Characteristics of grinding wheel:

1. **Abrasive material** – Al_2O_3 (steel), SiC (cast iron, carbide), CBN (hard steels), Diamond (carbides)
2. **Grain size** – Coarse (rapid stock removal), Fine (finish)
3. **Grade (hardness)** – Soft wheel for hard materials (self-sharpening), Hard wheel for soft materials
4. **Structure** – Open for soft materials (chip clearance), Dense for hard materials
5. **Bond type** – Vitrified (common), Resinoid (cut-off wheels), Rubber (flexible)

Wheel selection procedure:

1. **Material to grind:** Steel → Al_2O_3; Carbide → Diamond.
2. **Stock removal & finish:** Roughing → Coarse grit (24–36), Finishing → Fine (60–80).
3. **Wheel hardness:** Hard material → Soft grade (J–K); Soft material → Hard grade (L–N).
4. **Operation type:** Surface grinding → Medium structure; Cylindrical → Dense structure.
5. **Machine rigidity:** Rigid → Hard wheel; Flexible → Soft wheel.

Example: Grinding HSS tool bit on bench grinder: A 46 K 5 V.

Q.4 – Explain types of grinding wheel and its selection process. (4 marks)
Appeared in: S22(4), W24(4)
Ans: (Brief version of Q.71)
Types:

- Straight wheel
- Cylinder wheel
- Tapered wheel (type 4)
- Cup wheel (for tool grinding)
- Dish wheel
- Cut-off wheel

Selection process: Match abrasive, grain size, grade, structure, bond to workpiece material and operation.

Q.5 – Describe coding of grinding wheel as per ISI. (3 marks)
Appeared in: S25(3), W25(4) → Use 4 marks? Highest is 4 from W25. But separate from Q.69? Q.69 already 7 marks covering ISI. So to avoid duplication, answer concisely.
Ans:
ISI code (IS 551) format:
[Abrasive] [Grain size] [Grade] [Structure] [Bond]
Example: A 46 K 5 V

- A = Al_2O_3, 46 = medium grain, K = medium soft, 5 = dense, V = vitrified.
  Full code may include manufacturer prefix and suffix.

Q.6 – Define dressing of grinding wheel. Which operation alters shape of grinding wheel? (3 marks)
Appeared in: W25(3)
Ans:
Dressing: Process of removing dull grains and loading from wheel face to restore cutting

action.
Operation that alters shape: Truing (corrects wheel geometry, e.g., makes it round and concentric).
Note: Dressing changes surface topography, not shape; Truing changes shape.

Q.7 – Explain centerless grinders along with advantages and limitations. (4 marks)
Appeared in: W25(4), W22(4)
Ans:
Centerless grinding: Workpiece is not held between centres but supported by:

- **Regulating wheel** (controls rotation & feed)
- **Grinding wheel** (does actual cutting)
- **Work rest blade** (supports from below)

Working principle:

- Workpiece placed between wheels.
- Grinding wheel rotates at high speed; regulating wheel rotates slower (0.1–10 m/min).
- Axial feed by tilting regulating wheel.

Advantages:

- High production (1000+ parts/hour)
- No centering needed
- Suitable for long thin parts

Limitations:

- Cannot grind non-cylindrical shapes
- Costly setup for small batches
- Less accurate for interrupted surfaces

Real-world application: Needle roller bearing pins (mass production).

Q.8 – Describe cylindrical grinding machine with sketch. (4 marks)
Appeared in: S22(4)
Ans:
Construction:

- Heavy bed with headstock (work rotating) and tailstock.
- Wheelhead (with grinding wheel) moves on cross & longitudinal slides.
- Internal grinding attachment optional.

Working:

- Workpiece rotates between centres or on chuck.
- Wheel rotates at high speed (1500–3000 rpm).
- Wheelhead traverses back & forth (longitudinal feed).

[DG]

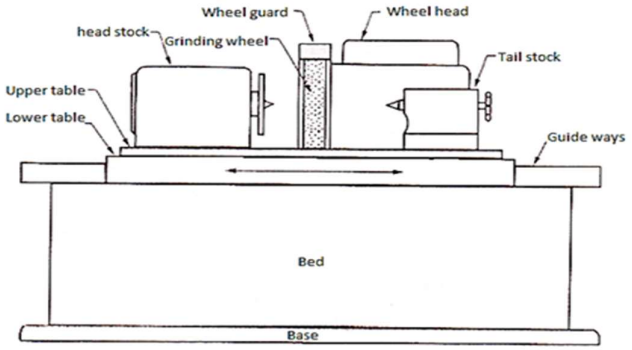


Fig.8.7 – Plain Cylindrical Grinders

Applications: Grinding journal diameters of crankshafts, piston rods.

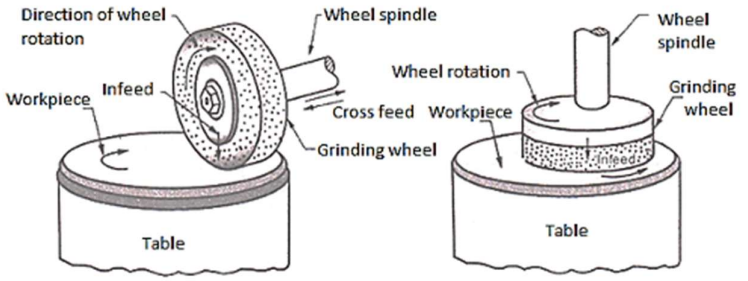
Q.9 – Illustrate surface grinding machine with neat sketch. (7 marks)
Appeared in: S22(7), W23(7)
Ans:
Two types: Reciprocating table & Rotary table.
Construction (reciprocating type):

- Base with horizontal table (reciprocates).
- Column with vertical spindle (or horizontal spindle).
- Grinding wheel mounted on spindle.

Working:

- Workpiece clamped on magnetic chuck.
- Table moves left–right (longitudinal feed).
- Wheelhead moves cross & vertical increments.

[DG]



a. *Horizontal spindle rotary table surface grinder*
b. *Vertical spindle rotary table surface grinder*

Fig.8.13 – Surface grinders

Applications:

- Flat surfaces of dies, mould plates
- Precision gauge blocks (finish Ra 0.1 µm)

Advantages: High surface finish, tight tolerances (±0.005 mm).
Limitations: Only flat surfaces; slow for heavy stock removal.

Q.10 – Explain different types of grinding processes. (3 marks)
Appeared in: W22(3)
Ans:
Grinding processes classified by surface generated:

1. **Surface grinding** – Flat surfaces (peripheral or face grinding)
2. **Cylindrical grinding** – External & internal diameters
3. **Centerless grinding** – Through-feed, in-feed
4. **Tool & cutter grinding** – Sharpening drills, end mills
5. **Creep feed grinding** – Deep cuts, low feed (high MRR)
6. **Form grinding** – Contoured shapes

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