

# GUJARAT TECHNOLOGICAL UNIVERSITY

BE-4 SEMESTER – MID TERM – S26 – ANSWER BANK

**Subject Name & Code:**  
**MANUFACTURING PROCESSES-BE04000191**

## Manufacturing Processes (BE04000191) - Mid Term Exam Answer Bank

(7 Marks Each - Concise Version)

**Q.1 Explain radial drilling machine with neat sketch. (7 Marks)**

**Answer:**

**Definition:** A drilling machine with a radial arm that swings around a vertical column, allowing drilling at any position on large workpieces without moving them.

**Construction:**

Component	Function
<b>Base</b>	Heavy cast iron foundation with T-slots for clamping
<b>Column</b>	Vertical cylindrical column; arm moves up/down and rotates
<b>Radial Arm</b>	Horizontal arm that swings 360° and moves vertically
<b>Drilling Head</b>	Contains motor, spindle, gearbox; moves along arm
<b>Spindle</b>	Rotating component with Morse taper for tool holding

**Motions:**

1. Arm rotation (360° around column)
2. Arm vertical movement (height adjustment)
3. Drilling head horizontal movement (along arm)
4. Spindle feed (vertical cutting motion)

**Working:**

- Workpiece clamped on base (stationary)
- Arm positioned at required height
- Drilling head moved to hole location
- Drill fed vertically into workpiece

**Advantages:**

- Drills large, heavy workpieces without moving them
- Any position within arm radius accessible
- Suitable for tool rooms and mass production

**Diagram:**

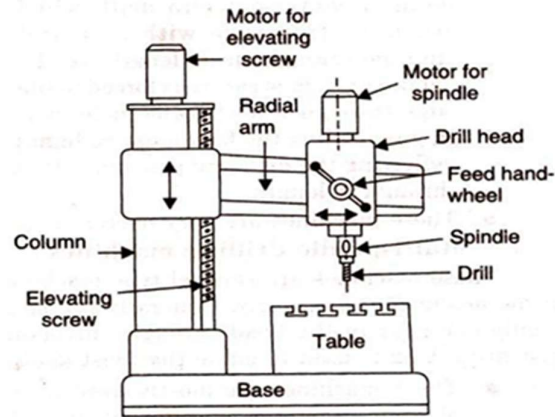


Fig.3.4 Radial Drilling Machine

**Q.2 Draw a sketch of simple twist drill with tapered shank and show its various elements. (7 Marks)**

**Answer:**

**Twist Drill Elements:**

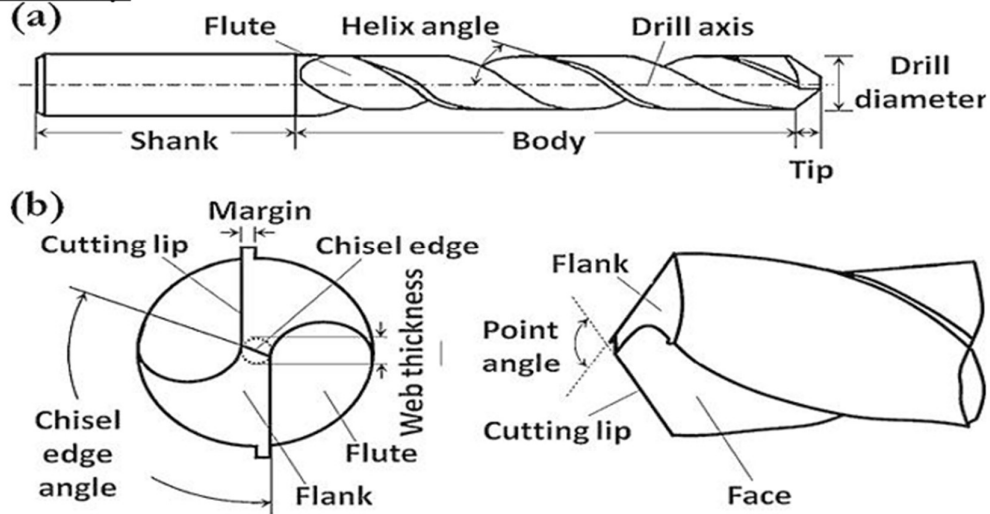
Element	Description
<b>Shank</b>	Tapered end (Morse taper) for direct spindle mounting
<b>Tang</b>	Flat end preventing slip in spindle
<b>Body</b>	Main portion between shank and point
<b>Flutes</b>	Helical grooves for chip removal and coolant flow
<b>Land</b>	Solid portion between flutes
<b>Margin</b>	Narrow strip maintaining drill diameter
<b>Point</b>	Conical cutting end
<b>Lip</b>	Cutting edge at point
<b>Chisel Edge</b>	Small cutting edge at center
<b>Web</b>	Central core connecting lands

**Key Angles:**

- **Point Angle:** 118° (general purpose), 135° (hard materials)
- **Lip Relief Angle:** 8-12°
- **Helix Angle:** 24-32°

**Diagram:**

Drill Geometry:



**Q.3 Explain Grinding wheel designation system in detail. (7 Marks)**

**Answer:**

**BIS Grinding Wheel Marking System:**

**Sequence:** Abrasive - Grain Size - Grade - Structure - Bond

**1. Abrasive:**

Symbol	Material	Application
A	Aluminum Oxide	Ferrous metals
C	Silicon Carbide	Non-ferrous, cast iron
D	Diamond	Carbide tools

**2. Grain Size:**

Type	Grit Numbers
Coarse	10, 12, 14, 16, 20, 24
Medium	30, 36, 46, 54, 60
Fine	80, 100, 120, 150, 180
Very Fine	220, 240, 280, 320, 400, 500

**3. Grade (Hardness):**

Type	Letters
Soft	A, B, C, D, E, F, G, H

Type	Letters
Medium	I, J, K, L, M, N, O, P
Hard	Q, R, S, T, U, V, W, X, Y, Z

**4. Structure:**

Type	Numbers
Dense	1, 2, 3, 4, 5, 6, 7, 8
Medium	9, 10, 11, 12
Open	13, 14, 15+

**5. Bond:**

Symbol	Bond	Characteristics
V	Vitrified	Most common, rigid
B	Resinoid	Flexible, cut-off wheels
R	Rubber	Very flexible
S	Silicate	Large wheels, cool cutting

**Example:** A 46 L 4 V

- A = Aluminum Oxide
- 46 = Medium grain
- L = Medium grade
- 4 = Dense structure
- V = Vitrified bond

**Dimensions:** Also specified as Diameter × Thickness × Bore (e.g., 250 × 25 × 32 mm)

**Q.4 List the methods of taper turning on a lathe machine. Describe a method suitable for long jobs with a neat sketch. (7 Marks)**

**Answer:**

**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

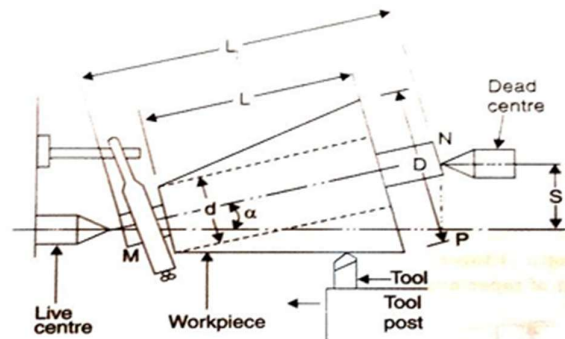
**Diagram:**

Fig.2.24 Taper turning by setting tail stock

**Q.5 Explain about dressing and truing of grinding wheel. (7 Marks)****Answer:****Dressing:**

**Definition:** Process of removing dull abrasive grains and loaded material from wheel surface to restore cutting ability.

**Purpose:**

- Removes glazed or loaded surface
- Exposes fresh sharp grains
- Restores cutting efficiency
- Improves surface finish

**Methods:**

Method	Tool	Application
Star Dresser	Star-shaped discs	Rough dressing
Abrasive Stick	SiC stick	Tool room work
Diamond Dresser	Single/multi-point diamond	Precision grinding
Abrasive Wheel	SiC wheel	Cylindrical grinders

**Truing:**

**Definition:** Process of making grinding wheel concentric with its axis and restoring correct shape.

**Purpose:**

- Corrects wheel runout
- Ensures concentricity
- Restores wheel profile
- Eliminates out-of-round condition

**Methods:**

- Diamond truing (most common)
- Abrasive wheel truing
- Crush truing (for form wheels)

**Comparison:**

Parameter	Dressing	Truing
Purpose	Restore cutting ability	Restore shape/concentricity
Action	Removes dull grains	Corrects geometry
Frequency	More frequent	Less frequent

**Q.6 Explain centerless grinders along with their advantages and limitations. (7 Marks)****Answer:****Centerless Grinding:**

**Principle:** Workpiece supported by combination of grinding wheel, regulating wheel, and work rest blade (no centers used).

**Components:**

Component	Function
Grinding Wheel	High-speed abrasive wheel for material removal

Component	Function
Regulating Wheel	Controls workpiece rotation and feed
Work Rest Blade	Supports workpiece between wheels

**Feeding Methods:**

Method	Application
Through-feed	Long, straight cylindrical parts
Infeed (Plunge)	Shouldered parts, formed surfaces
End-feed	Spherical, tapered surfaces

**Advantages:**

- No centering required; eliminates fixtures
- Continuous process - high production rates
- Rigid support along entire workpiece length
- Heavy cuts possible
- Reduced wheel wear (larger wheels)
- Less skilled operation
- Direct size adjustment

**Limitations:**

- Difficult for multiple diameter workpieces
- No guarantee of OD-ID concentricity (hollow parts)
- Longer setup time
- Limited to cylindrical parts
- Special work rest blades required

**Applications:** Bushings, pistons, valves, tubes, bearing balls, hydraulic cylinders

**Q.7 Explain tool wear and tool life. (7 Marks)**

**Answer:**

**Tool Wear:**

**Definition:** Gradual deterioration of cutting tool during machining, leading to loss of cutting efficiency.

**Types:**

Type	Location	Characteristics
<b>Crater Wear</b>	Tool face	Concave depression from chip sliding; weakens tool
<b>Flank Wear</b>	Tool flank	Wear land from friction with workpiece; increases cutting forces
<b>Corner Wear</b>	Tool nose	Affects dimensional accuracy

**Wear Limits:**

- Flank wear ( $V_B$ ) > 0.5-0.6 mm = tool failure
- Crater depth ( $K_T$ ) affects tool strength

**Tool Life:**

**Definition:** Duration of actual cutting time after which tool is no longer usable.

**Taylor's Tool Life Equation:**

$$VT^n = C$$

Where:

- $V$  = Cutting speed (m/min)
- $T$  = Tool life (minutes)
- $n$  = Exponent (tool material constant)
- $C$  = Constant (speed for 1 min life)

**Typical n Values:**

Tool Material	n
HSS	0.08-0.12
Carbide	0.20-0.30
Ceramics	0.40-0.60

**Extended Equation:**

$$VT^n d^m f^x = C$$

**Factors Affecting Tool Life:**

Factor	Effect
Cutting Speed	Most important; ↑speed ↓life
Feed Rate	↑feed ↓life
Depth of Cut	↑depth ↓life
Tool Material	Harder = longer life
Coolant	Increases life

**Q.8 Compare Capstan Lathe, Turret Lathe and Centre Lathe. (7 Marks)**

**Answer:**

Parameter	Centre Lathe	Capstan Lathe	Turret Lathe
<b>Type</b>	General purpose	Production	Production
<b>Duty</b>	Light-medium	Light duty	Heavy duty

Parameter	Centre Lathe	Capstan Lathe	Turret Lathe
<b>Tailstock</b>	Present	Replaced by turret	Replaced by turret
<b>Turret Mounting</b>	N/A	On ram; ram on saddle	Direct on saddle
<b>Saddle Movement</b>	Moves along bed	Fixed; ram moves	Moves with turret
<b>Work Holding</b>	Chuck/centers	Collet chuck	Jaw chuck
<b>Work Size</b>	Wide range	Up to 60 mm	Up to 200 mm
<b>Rigidity</b>	Moderate	Less rigid	Very rigid
<b>Multiple Tools</b>	No	Yes	Yes
<b>Simultaneous Ops</b>	No	Possible	Possible
<b>Operator Skill</b>	High	Lower	Lower
<b>Production Rate</b>	Low	High	High
<b>Setup Time</b>	Less	More	More
<b>Cost</b>	Lower	Moderate	Higher
<b>Typical Use</b>	Tool room, repair	Bar work	Chuck work

**Key Points:**

- **Centre Lathe:** Versatile, single tool, small batches
- **Capstan Lathe:** Light production, ram-mounted turret, bar work
- **Turret Lathe:** Heavy production, saddle-mounted turret, large workpieces

**Q.9 Explain the tool geometry of single point cutting tool. (7 Marks)****Answer:****Tool Elements:**

- **Shank:** Main body gripped in holder
- **Face:** Top surface; chips flow here
- **Flank:** Surface below cutting edge
- **Point:** Wedge where face and flank meet
- **Nose:** Cutting tip with radius

**Tool Angles (ASA System):**

Angle	Symbol	Function	Typical Range
Back Rake	$\alpha_b$	Controls chip flow	8-20°

Angle	Symbol	Function	Typical Range
Side Rake	$\alpha_s$	Reduces friction	10-20°
End Relief	$\theta_e$	Prevents rubbing	5-8°
Side Relief	$\theta_s$	Provides clearance	5-8°
End Cutting Edge	$C_e$	Prevents trailing edge rub	6-15°
Side Cutting Edge	$C_s$	Distributes cutting force	15-30°
Nose Radius	R	Improves finish, strength	0.4-1.6 mm

**Tool Signature (ASA):**

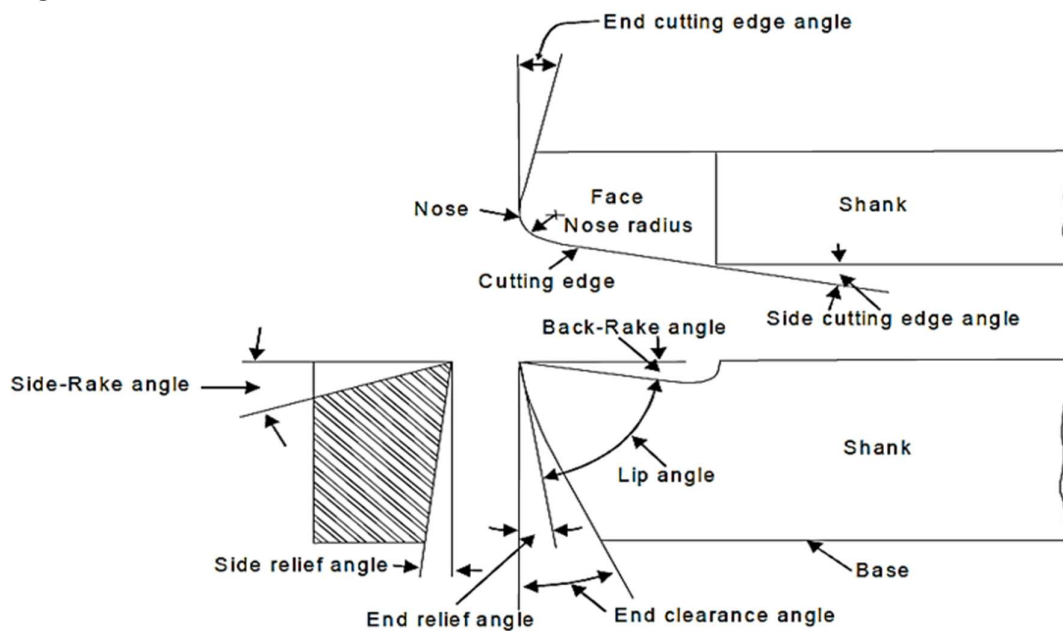
$$\alpha_b - \alpha_s - \theta_e - \theta_s - C_e - C_s - R$$

**Example:** 8 – 14 – 6 – 6 – 6 – 15 – 1/8

**Effect of Angles:**

- **Positive Rake:** Lower cutting force, weaker edge
- **Negative Rake:** Higher strength, increased force
- **Larger Side Cutting Edge:** Reduces chip thickness, increases tool life
- **Larger Nose Radius:** Better finish, may cause chatter

**Diagram:**



### Single point cutting tool geometry

**Q.10 Why cutting forces are measured? What are the different ways to measure cutting forces. (7 Marks)**

**Answer:**

**Why Cutting Forces are Measured:**

Purpose	Explanation
Machine Design	Determines power needs and rigidity requirements
Tool Design	Optimizes geometry and material
Process Optimization	Selects best speed, feed, depth
Power Calculation	Determines actual machining power
Tool Wear Monitoring	Force increase indicates wear
Chatter Prediction	Prevents vibration
Research	Validates theoretical models

**Force Components:**

- **Cutting Force ( $F_c$ ):** Tangential; determines power
- **Thrust Force ( $F_t$ ):** Radial; affects deflection
- **Feed Force ( $F_f$ ):** Axial; contributes to power

**Methods to Measure Cutting Forces:**

**1. Dynamometer Types:**

Type	Principle	Application
Mechanical	Spring deflection	Basic research
Hydraulic	Fluid pressure	Heavy cutting
Electrical (Strain Gauge)	Resistance change	Precision measurement
Piezoelectric	Quartz crystal charge	Dynamic forces

**2. Strain Gauge Dynamometer:**

- Elastic member with strain gauges
- Wheatstone bridge circuit
- Measures 2 or 3 force components
- High sensitivity, good frequency response

**3. Piezoelectric Dynamometer:**

- Quartz crystal sensors
- Charge amplifier
- Very high natural frequency
- Excellent dynamic response

**4. Tool Post Dynamometer:**

- Mounted between tool and tool post
- Used for turning operations

**5. Table Dynamometer:**

- Workpiece mounted on dynamometer
- Used for milling, drilling

**Typical Setup:**

Sensors → Amplifier → Signal Conditioner → Data Acquisition → Computer

**Q.11 Explain primary and auxiliary motions with reference to machine tool. (7 Marks)**

**Answer:**

**Primary Motions:**

**Definition:** Motions that directly perform metal removal; power-driven and essential for cutting.

**Types:**

Type	Description	Example
<b>Principal/Cutting Motion</b>	Main motion causing material removal	Workpiece rotation (lathe), Ram reciprocation (shaper)
<b>Feed Motion</b>	Positions tool for successive cuts	Tool longitudinal movement (lathe)

**Forms of Principal Motion:**

- Rotary (lathe spindle, drill spindle)
- Reciprocating (shaper ram, planer table)
- Combined (both rotary and reciprocating)

**Characteristics:**

- Power-driven
- Determines cutting speed
- Consumes most machine power

**Auxiliary Motions:**

**Definition:** Motions that assist machining process but don't directly remove metal.

Motion	Description	Example
Handling/Clamping	Positioning and securing workpiece	Chuck clamping
Advance/Withdrawal	Moving tool to/from workpiece	Tool approach
Engagement/Disengagement	Connecting/disconnecting drives	Clutch engagement
Speed Change	Altering spindle speeds	Gear shifting
Tool Positioning	Setting tool location	Centering
Indexing	Rotating to next position	Turret indexing

**Characteristics:**

- Hand-operated in conventional machines
- Power-driven in automatic machines

- No direct material removal

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**Comparison:**

Parameter	Primary Motions	Auxiliary Motions
Purpose	Metal removal	Assist machining
Power	Power-driven	Hand or power
Effect	Direct material removal	No material removal
Examples	Rotation, feed	Clamping, indexing

**Examples in Lathe:**

- **Primary:** Workpiece rotation, tool feed
  - **Auxiliary:** Chuck clamping, tool approach, speed change, tailstock movement
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**Q.12 Name the accessories commonly used to enhance lathe operations. Explain the different types of mandrels. (7 Marks)**

**Answer:**

**Common Lathe Accessories:**

Accessory	Function
Chucks	Holding workpieces (3-jaw, 4-jaw, collet)
Face Plate	Holding large/irregular work
Centers	Supporting work (live/dead)
Lathe Dog	Driving work between centers
Mandrels	Holding bored parts for external machining
Steady Rest	Supporting long work at intermediate points
Follower Rest	Supporting flexible work near tool
Drive Plate	Driving lathe dog

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**Mandrels:**

**Definition:** Solid steel shaft used for holding bored parts to machine external surfaces concentrically.

**Types of Mandrels:**

Type	Construction	Application	Best For
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Type	Construction	Application	Best For
<b>Solid/Plain</b>	Slight taper (0.01-0.02 mm/100 mm)	Work with finished holes	High accuracy
<b>Collar</b>	Solid with integral collar	Longer work	End location
<b>Stepped</b>	Multiple diameters	Different hole sizes	Versatility
<b>Expanding</b>	Split sleeve with tapered plug	Thin walls, precision	Concentric grip
<b>Double Cone</b>	Two tapered cones	Long/thin work	Even expansion
<b>Threaded</b>	Threaded shaft	Threaded components	Quick mounting

**Solid Mandrel:**

- Workpiece pressed onto taper
- Driven by lathe dog
- Simple and rigid

**Expanding Mandrel:**

- Split sleeve expands when tapered core is drawn in
- Provides even pressure
- Does not damage bore

**Double Cone Mandrel:**

- Cones drawn together by nut
- Expands along entire length
- Suitable for long workpieces

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