

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - 5 SEMESTER – MID TERM – W26 – ANSWER BANK

Subject Name & Code:

MANUFACTURING TECHNOLOGY- BE05000311

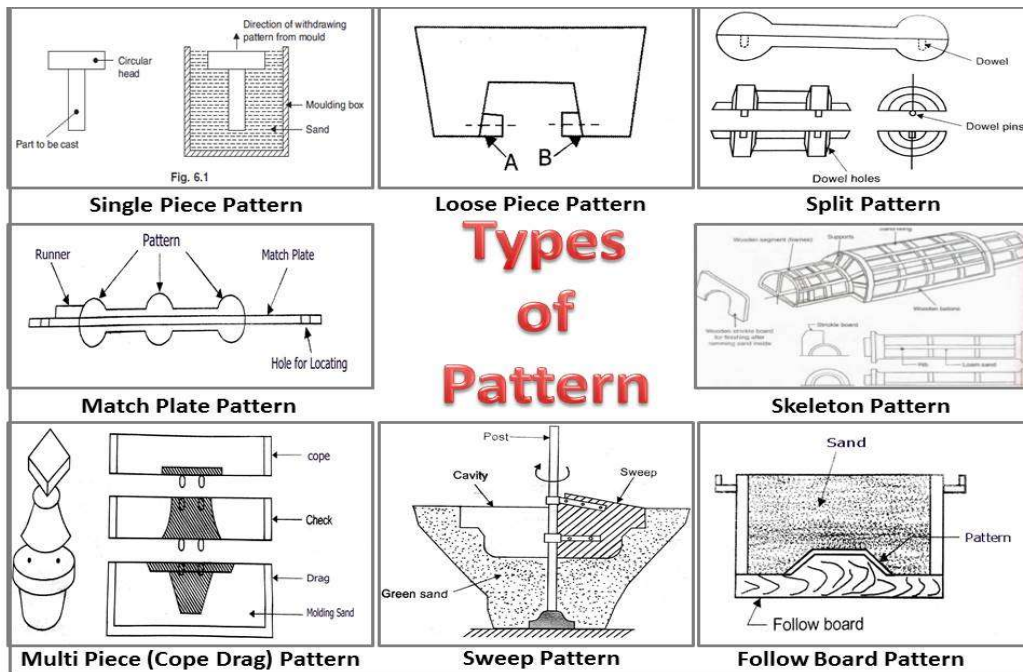
Unit 1 - Foundry Technology

1) Explain classification of patterns with neat sketches

4 Mark Answer:

Patterns classified based on:

- **One-piece/solid pattern** - Simple, single piece, used for simple castings
- **Split pattern** - Divided into two halves along parting plane
- **Cope and drag pattern** - Split pattern with gating system included
- **Loose piece pattern** - Has removable pieces for undercuts
- **Sweep pattern** - Rotated to generate symmetrical shapes
- **Skeleton pattern** - Framework covered with sand



2) Discuss various pattern allowances with justification

4 Mark Answer:

Pattern allowances provide dimensional corrections:

- **Shrinkage allowance** - Compensates for metal contraction during solidification (1-2%)
- **Machining allowance** - Extra material for final machining (1.5-3mm)
- **Draft allowance** - Taper for easy pattern removal (1-3°)
- **Rapping allowance** - Compensates for mould cavity enlargement during pattern withdrawal
- **Distortion allowance** - Prevents warping in complex castings

3) Describe properties of good moulding sand and tests

4 Mark Answer:

Properties:

- **Permeability** - Allows gases to escape during pouring
- **Green strength** - Holds shape when moist
- **Dry strength** - Maintains integrity after drying
- **Refractoriness** - Withstands high temperatures
- **Adhesiveness** - Binds sand grains together

Tests:

- **Permeability test** - Measures gas flow rate
- **Compression test** - Checks green and dry strength
- **Shatter test** - Evaluates toughness
- **Moisture content test** - Determines water percentage

4) Explain green sand moulding process step by step

3 Mark Answer:

1. **Pattern placement** - Place pattern on moulding board
2. **Drag filling** - Fill drag box with prepared green sand and ram
3. **Turnover** - Invert drag and place cope
4. **Cope filling** - Fill cope with sand and ram
5. **Pattern removal** - Split pattern and withdraw
6. **Core placement** - Insert cores if required
7. **Closing** - Assemble cope and drag
8. **Pouring** - Pour molten metal into cavity

5) Compare shell moulding and investment casting

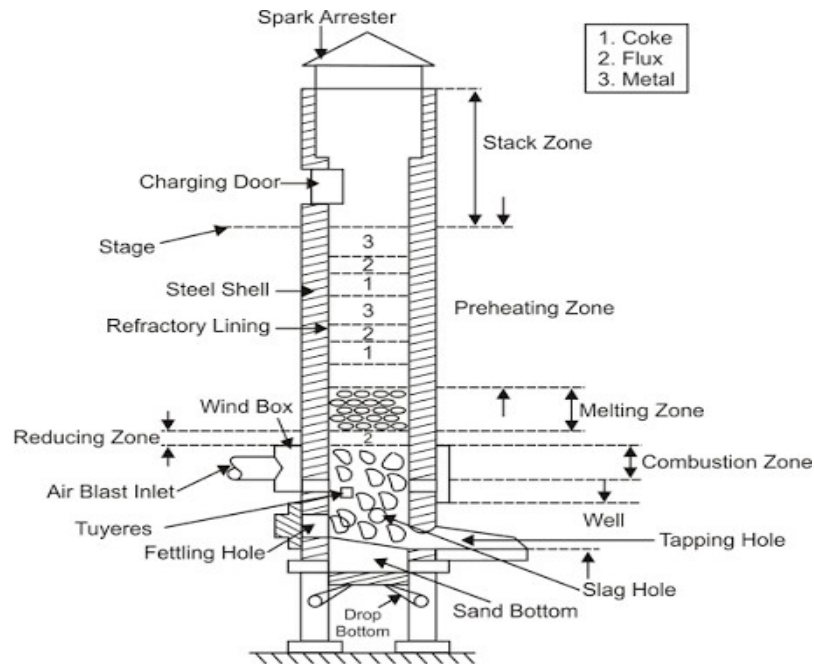
4 Mark Answer:

Feature	Shell Moulding	Investment Casting
Pattern	Metal pattern heated	Wax pattern
Material	Resin-coated sand	Ceramic slurry
Process	Sand heated on pattern	Wax melted out
Accuracy	Good ($\pm 0.5\text{mm}$)	Excellent ($\pm 0.1\text{mm}$)
Surface finish	Smooth	Very smooth
Production	High volume	Low-medium volume
Cost	Moderate	High

6) Explain working of cupola furnace with sketch

4 Mark Answer:

Sketch:



Working principle:

- **Charging** - Coke, limestone and metal charged alternately
- **Preheating** - Air blast through tuyeres burns coke
- **Melting** - Metal melts and flows down over coke bed
- **Slag removal** - Slag floats on metal surface, removed through slag hole
- **Tapping** - Molten metal collected periodically through tapping hole

7) Describe five casting defects, causes and remedies

4 Mark Answer:

Defect	Cause	Remedy
Blowholes	Trapped gases	Increase permeability, proper venting
Sand inclusion	Loose sand erosion	Proper ramming, adequate binder
Shrinkage cavity	Insufficient feeding	Proper riser design, feeding
Misrun	Low pouring temperature	Increase pouring temperature
Cold shut	Low metal fluidity	Increase temperature, redesign gating

8) Discuss design considerations for gating system (4 Mark Answer)

Gating system design principles:

- **Pouring basin** - Maintains constant metal head and stops slag
- **Sprue** - Vertical channel, tapered to prevent air aspiration
- **Runner** - Horizontal channel distributing metal to gates
- **Gates/Ingates** - Enters mould cavity smoothly to prevent erosion
- **Risers** - Feed metal during solidification to prevent shrinkage
- **Choke area** - Controls metal flow rate (smallest cross-section)

Unit 2 - Metal Joining Processes

1) Classify welding processes and describe categories

3 Mark Answer:

Classification:

1. **Arc welding** - SMAW, GMAW, GTAW, SAW
2. **Gas welding** - Oxy-acetylene, oxy-hydrogen
3. **Resistance welding** - Spot, seam, projection
4. **Solid state welding** - Friction, ultrasonic, diffusion
5. **Thermit welding** - Chemical reaction
6. **Electron beam/Laser welding** - High energy

2) Explain oxy-acetylene welding, equipment and flames

4 Mark Answer:

Definition: Joining process using heat from combustion of oxygen and acetylene gas.

Equipment:

- **Oxygen cylinder** - High pressure (150 kg/cm²)
- **Acetylene cylinder** - Dissolved in acetone
- **Regulators** - Reduce pressure to working level
- **Hoses** - Deliver gases to torch
- **Welding torch** - Mixes gases and produces flame
- **Filler rod** - Adds material to joint

Flame types:

- **Neutral flame** - Equal O₂ and C₂H₂ (most common)
- **Carburizing flame** - Excess acetylene
- **Oxidizing flame** - Excess oxygen

3) Describe arc welding, power sources and polarity

3 Mark Answer:

Arc welding: Joining process using electric arc between electrode and workpiece to melt metal.

Power sources:

- **AC transformer** - Step down voltage, for general welding
- **DC generator** - For smooth arc, better control
- **Rectifier** - Converts AC to DC

Polarity:

- **DCSP (Straight)** - Workpiece positive, electrode negative - Deep penetration
- **DCRP (Reverse)** - Workpiece negative, electrode positive - Shallow penetration, better cleaning

4) Differentiate TIG and MIG welding

4 Mark Answer:

Feature	TIG (GTAW)	MIG (GMAW)
Electrode	Non-consumable tungsten	Consumable wire
Shielding gas	Argon/Helium	CO ₂ /Argon mix
Filler metal	Separate rod	Continuous wire electrode

Feature	TIG (GTAW)	MIG (GMAW)
Process	Slow, precise	Fast, high production
Thickness	Thin sections	Thin to medium sections
Materials	Al, Mg, Stainless	Mild steel, Al, Stainless

5) Explain resistance spot and seam welding

3 Mark Answer:

Resistance spot welding:

- Two electrodes apply pressure and current
- Current heats metal at contact point
- Nugget forms and joins sheets
- Used for sheet metal (automobile industry)

Resistance seam welding:

- Rotating disc electrodes roll over workpiece
- Continuous overlapping spots formed
- Produces leak-proof joints
- Used for fuel tanks, containers

6) Distinguish brazing, braze welding and soldering

4 Mark Answer:

Feature	Brazing	Braze Welding	Soldering
Temperature	>450°C	>450°C	<450°C
Filler metal	Non-ferrous alloy	Similar to base	Soft alloy (Sn-Pb)
Joint action	Capillary action	Deposited in groove	Capillary action
Strength	High	Very high	Low
Gap	0.05-0.1mm	Groove filled	0.05-0.1mm
Applications	Pipe joining	Heavy sections	Electronics, plumbing

7) Discuss welding defects, causes and remedies

4 Mark Answer:

Defect	Cause	Remedy
Porosity	Gas entrapment	Clean surfaces, proper shielding
Cracks	Rapid cooling, stress	Preheat, slow cooling

Defect	Cause	Remedy
Slag inclusion	Improper cleaning	Clean between passes
Underfill	Insufficient filler	Proper weld technique
Distortion	Thermal expansion	Clamping, proper sequence
Incomplete penetration	Low current/speed	Increase current, reduce speed

8) Explain any two advanced welding processes

4 Mark Answer:

Electron Beam Welding (EBW):

- High-velocity electron beam in vacuum
- Deep penetration with narrow HAZ
- No filler metal required
- Used for aerospace and nuclear components

Laser Welding:

- Focused laser beam as heat source
- High precision, minimal distortion
- No vacuum required
- Used in electronics, automotive, medical devices

9) Differentiate welding, soldering and brazing

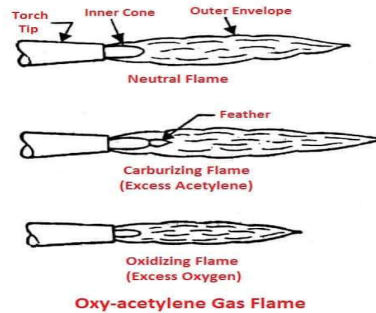
4 Mark Answer:

Feature	Welding	Brazing	Soldering
Temperature	Melts base metal	Below base metal	Below base metal
Filler	Same/different	Non-ferrous alloy	Soft alloy (Sn-Pb)
Joint strength	Highest	High	Low
Base metal melting	Yes	No	No
Metallurgical bond	Yes (fusion)	No (adhesion)	No (adhesion)
Applications	Structural	Pipe joining	Electronics

10) Illustrate various gas-welding flames with sketches

7 Mark Answer:

Sketch:



Types of Gas Welding Flames:

1. Neutral Flame:

- **Ratio:** $O_2:C_2H_2 = 1:1$
- **Appearance:** Well-defined inner cone (white), blue intermediate zone, pale outer envelope
- **Temperature:** Inner cone $\sim 3200^\circ C$
- **Characteristics:** No chemical effect on metal, most common
- **Applications:** Steel, stainless steel, cast iron, aluminum, copper

2. Oxidizing Flame:

- **Ratio:** $O_2:C_2H_2 > 1:1$ (excess oxygen)
- **Appearance:** Short, sharp inner cone, small intermediate zone
- **Temperature:** $\sim 3300^\circ C$ (hottest)
- **Characteristics:** Hissing sound, oxidizing effect
- **Applications:** Brass, bronze, copper (surface oxidation desired)
- **Caution:** Not for steel (causes oxidation)

3. Carburizing Flame:

- **Ratio:** $O_2:C_2H_2 < 1:1$ (excess acetylene)
- **Appearance:** Inner cone with feathery acetylene stream (greenish), large intermediate zone
- **Temperature:** $\sim 3000^\circ C$ (coolest)
- **Characteristics:** Adds carbon to metal
- **Applications:** Aluminum alloys, high carbon steels, carburizing applications
- **Caution:** Not for brass/bronze (causes porosity)

11) Define resistance welding and explain seam welding

3 Mark Answer:

Resistance welding: Joining process where heat is generated by electrical resistance between contacting surfaces under pressure.

Seam welding:

- Rotating wheel electrodes roll over overlapped sheets
- Current flows through point of contact
- Series of overlapping spot welds produced
- Creates continuous leak-proof joint
- Used for cans, tanks, pipes

12) Explain submerged arc welding with advantages/disadvantages

4 Mark Answer:

SAW: Arc is shielded under granular flux blanket.

Working:

- Continuous electrode fed into joint

- Flux deposited ahead of electrode
- Arc submerged under flux
- Flux melts forming protective slag
- Slag removed after cooling

Advantages:

- High deposition rate
- Deep penetration
- No spatter or fumes
- Good weld quality

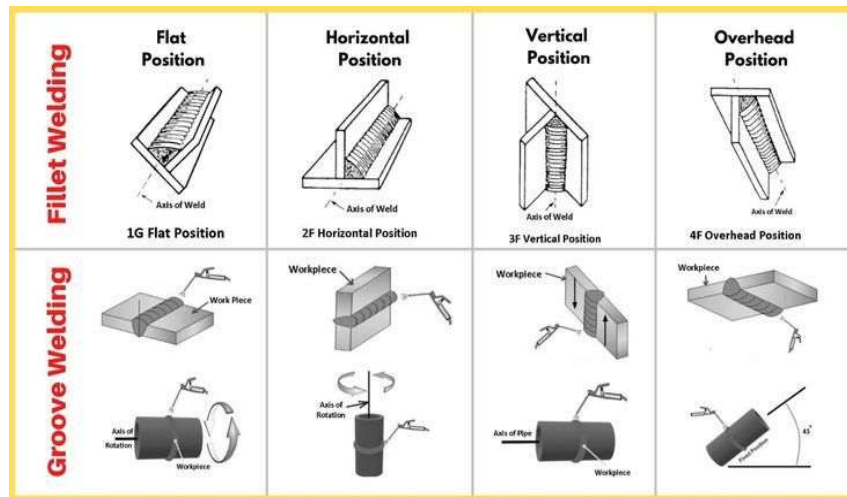
Disadvantages:

- Limited to flat/horizontal positions
- Requires flux handling equipment
- Not suitable for thin sheets

13) Explain various welding positions with sketches

7 Mark Answer:

Sketch:



Basic Welding Positions:

Flat Position (1F)

- **Plate:** Horizontal top surface
- **Weld:** On top of plate, electrode vertical downward
- **Gravity:** Helps (pool stays in place)
- **Difficulty:** Easiest, deepest penetration, highest deposition rate
- **Applications:** Grooves, fillet welds

Horizontal Position (2F)

- **Plate:** Vertical, weld horizontal
- **Electrode:** Tilted upward (5-15°)
- **Gravity:** Works against (pool can sag)
- **Difficulty:** Moderate
- **Applications:** Vertical plate butt joints

Vertical Position (3F)

- **Plate:** Vertical, weld vertical
- **Gravity:** Works against (pool flows down)
- **Methods:** Vertical Up (weaves, strong) and Vertical Down (fast, thin)
- **Difficulty:** Difficult
- **Applications:** Vertical joints, fillet welds

Overhead Position (4F)

- **Plate:** Horizontal underside
- **Weld:** On bottom, electrode pointing upward
- **Gravity:** Works strongly against (pool falls)
- **Difficulty:** Most difficult
- **Need:** Small weld pool, high skill
- **Applications:** Overhead joints, structural work

Pipe Positions

Position	Symbol	Description
Pipe Rolled	1G	Pipe rotated, weld on top
Pipe Fixed Horizontal	2G	Pipe fixed, weld vertical
Pipe Fixed Vertical	5G	Pipe vertical, weld horizontal
Pipe Inclined Fixed	6G	Pipe at 45°, most difficult

Difficulty Order (Easiest → Hardest):

Flat → Horizontal → Vertical → Overhead → Pipe 6G

14) Explain forward and backward welding process**3 Mark Answer:****Forward (Forehand) welding:**

- Torch points forward (45°)
- Filler rod ahead of torch
- Wider bead, good for thin sheets
- Less penetration

Backward (Backhand) welding:

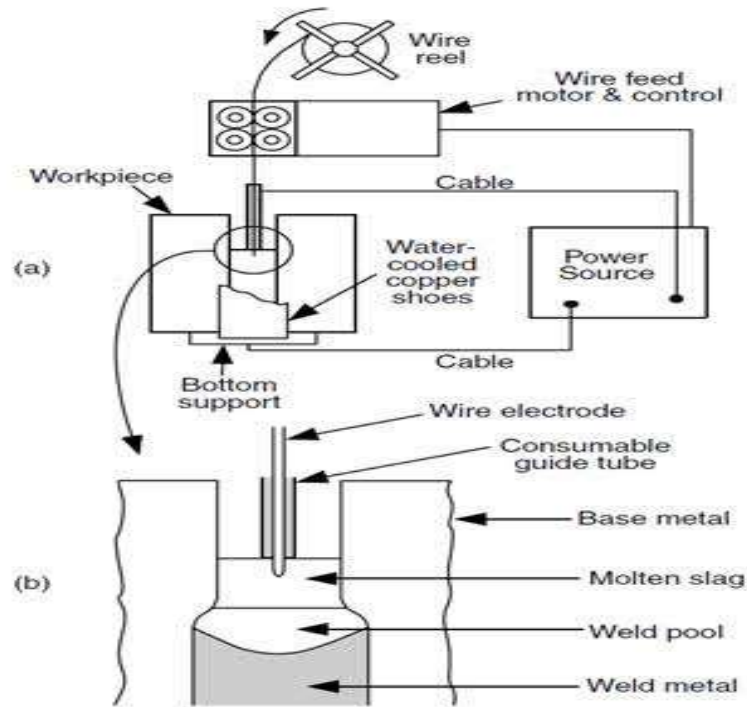
- Torch points backward (45°)
- Filler rod behind torch
- Narrow bead, deeper penetration
- Better for thicker sections

15) Classify metal joining processes**3 Mark Answer:**

1. **Welding** - Fusion and solid-state
2. **Brazing** - Above 450°C, capillary action
3. **Soldering** - Below 450°C
4. **Adhesive bonding** - Chemical bonding
5. **Mechanical fastening** - Rivets, bolts, screws

16) Explain principle of electroslag welding with sketch**3 Mark Answer:**

Sketch:



Principle:

- Arc initiated between electrode and workpiece
- Slag bath forms and resistance heats it
- Electrode melts and metal deposited
- Molten slag floats on metal pool
- Water-cooled shoes contain the pool
- Used for thick plates (>25mm)

17) Illustrate difference between TIG and MIG welding

4 Mark Answer:

Feature	TIG (GTAW)	MIG (GMAW)
Electrode	Non-consumable tungsten	Consumable wire
Arc characteristics	Stable, precise	Less precise
Shielding gas	Argon/Helium	CO ₂ /Argon mix
Filler addition	Manual from separate rod	Automatic from wire feed
Speed	Low	High
Thickness	Up to 6mm	Up to 25mm

Unit 3 - Forming and Shaping Processes

1) Differentiate hot working and cold working with examples

4 Mark Answer:

Feature	Hot Working	Cold Working
Temperature	Above recrystallization	Below recrystallization
Strength	No strain hardening	Strain hardening occurs
Surface finish	Rough, oxidized	Smooth, bright
Dimensional accuracy	Less accurate	Accurate
Energy required	Less	More
Applications	Large sections	Small precision parts
Examples	Rolling, forging	Wire drawing, cold rolling

2) Explain rolling process and roll-pass sequence

4 Mark Answer:

Rolling: Metal passed between rotating rolls to reduce thickness or change cross-section.

Roll-pass sequence:

- **First pass** - Preliminary reduction of ingot
- **Intermediate passes** - Progressive thickness reduction
- **Final pass** - Achieves final dimensions
- **Edging passes** - Controls width spread
- **Finishing passes** - Produces final shape

3) Describe open-die and closed-die forging

3 Mark Answer:

Open-die forging:

- Flat dies with no lateral constraint
- Metal freely flows in all directions
- Used for large, simple shapes
- Requires skilled operator

Closed-die (Impression) forging:

- Dies contain cavity of final shape
- Metal constrained laterally
- Produces complex shapes with close tolerances
- Uses flash to allow complete filling
- High production rates

4) Explain direct and indirect extrusion with applications

4 Mark Answer:

Direct (forward) extrusion:

- Ram pushes billet through die

- Friction between billet and container
- High force required initially
- Used for solid and hollow sections

Indirect (backward) extrusion:

- Die moves into stationary billet
- Metal flows opposite to ram direction
- No container friction
- Used for lower strength materials

Applications:

- Direct - Structural sections, rods, tubing
- Indirect - Collapsible tubes, toothpaste tubes

5) Describe wire drawing and tube drawing principles

3 Mark Answer:

Wire drawing:

- Wire pulled through converging die
- Reduces diameter and increases length
- Multiple dies with intermediate annealing
- Lubrication reduces friction

Tube drawing:

- Tube pulled through die with mandrel
- Mandrel controls internal diameter
- Four methods: sinking, plug, mandrel, floating plug
- Produces seamless tubes

6) Explain blanking, piercing, bending and deep drawing

4 Mark Answer:

Blanking: Punch cuts circular/desired shape from sheet, part is scrap

Piercing: Punch cuts hole in sheet, slug is scrap

Bending: Sheet deformed along straight axis

- V-bending, U-bending, edge bending
- Springback consideration

Deep drawing: Flat sheet formed into cylindrical/cup shape

- Punch forces sheet into die cavity
- Thickness remains nearly constant
- Used for automobile panels, kitchenware

7) Discuss forming defects, causes and remedies

4 Mark Answer:

Defect	Cause	Remedy
Buckling	High compressive stress	Reduce stress, improve support
Wrinkling	Insufficient blank holder force	Increase blank holder pressure
Lap/Seam	Folds in workpiece	Proper die clearance
Cracking	Excessive deformation	Anneal, reduce deformation

Defect	Cause	Remedy
Springback	Elastic recovery	Overbending, bottoming

8) State difference between hot and cold working

3 Mark Answer:

Hot Working	Cold Working
Above recrystallization temp	Below recrystallization temp
No strain hardening	Strain hardening occurs
Poor dimensional accuracy	Good dimensional accuracy
Less power required	More power required
Rough surface finish	Smooth surface finish

9) Explain strain hardening in metal forming

3 Mark Answer:

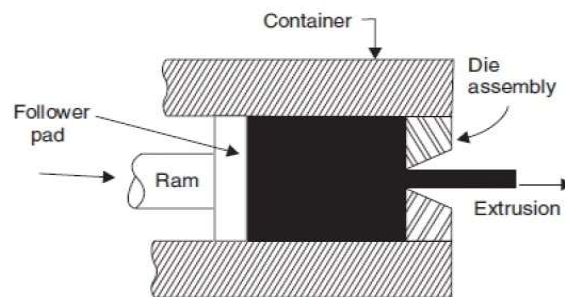
Strain hardening (Work hardening):

- Increased strength due to plastic deformation
- Dislocation multiplication and entanglement
- Results in increased hardness, yield strength
- Causes decrease in ductility and toughness
- Temporary effect - removed by annealing

10) Explain forward extrusion with neat sketch

4 Mark Answer:

Sketch:



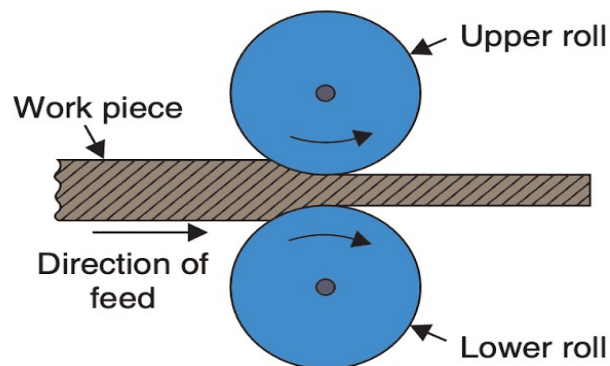
Forward or direct extrusion

Working:

- Billet placed in container
- Ram pushes billet towards die
- Material flows through die opening
- Product exits in same direction as ram
- Large force required due to container friction

11) Compare forward and backward extrusion**4 Mark Answer:**

Feature	Forward Extrusion	Backward Extrusion
Ram direction	Same as metal flow	Opposite to metal flow
Container friction	High	Low
Force required	Higher	Lower
Length of product	Unlimited	Limited
Die position	At one end	In hollow ram
Applications	Rods, tubes	Collapsible tubes

12) State principle of rolling with neat sketch**4 Mark Answer:****Sketch:****Principle:**

- Rolls rotate in opposite directions
- Workpiece pulled into gap by friction
- Thickness reduced and length increased
- Force necessary when roll gap less than workpiece
- Friction critical for success

13) Give classification of rolling process**3 Mark Answer:**

1. **By temperature** - Hot rolling, cold rolling
2. **By arrangement of rolls**
 - Two-high (reversing/non-reversing)
 - Three-high
 - Four-high
 - Cluster mill
 - Tandem mill

3. **By product**

- Sheet/plate rolling
- Rod/bar rolling
- Section rolling
- Shape rolling
