Q1/ Answer only twenty (20) of the multiple choice questions; [20D]

1. A finishing operation generally involves which one of the following combinations of cutting conditions? (a) high \(v\) (speed), \(f\) (feed) and \(d\) (depth of cut) (☻) high \(v\), low \(f\) and \(d\) (☻) low \(v\), high \(f\) and low \(d\) (☻) low \(v\), \(f\), and \(d\).

2. The ideal surface roughness in turning operation depends on which of the following parameters (two correct answers); (☻) feed (b) speed (c) depth of cut (☻) nose radius.

3. Which of the following types of chip would be expected in a turning operation conducted at low cutting speeds on a brittle work material; (a) continuous (b) continuous with built-up edge (☻) discontinuous (d) non of these.

4. Which of the following cutting condition has the strongest effect on cutting temperature; (a) feed (☻) speed (c) depth of cut (d) nose radius.

5. Which one of the following cutting tool materials has the highest hot hardness; (a) HCS (b) HSS (c) Cast cobalt alloys (☻) Ceramics.

6. Which one of the following machining processes will likely result in the worst surface finish? (☻) sawing (b) turning (c) milling (d) grinding.

7. Which one of the following cutting tool materials has the highest toughness; (a) carbides (☻) HSS (c) synthetic diamond (d) ceramics.

8. The important properties required in a tool material are; (three correct answers); (☻) toughness (☻) hot hardness (c) ductility (☻) wear resistance.

9. Deformation processes include which of the following (two correct answers); (a) casting (b) drilling (c) extrusion (d) forging (e) milling?

10. Which one of the following manufacturing processes will likely result in the worst surface finish; (a) cold rolling, (b) grinding (c) machining (☻) sand casting?

11. Which one of the following manufacturing processes will likely result in the best surface finish; (a) arc welding (☻) grinding (c) sand casting (e) sawing?

12. A feeder in casting is described by which of the following (three correct answers): (☻) waste metal that is usually recycled (b) gating system in which the sprue feeds directly into the cavity (☻) metal that is not part of the casting (☻) source of molten metal to feed the casting and compensate for shrinkage during solidification?

13. Which of the following casting processes are permanent mold operations (three correct answers); (☻) centrifugal casting (☻) die casting (c) expanded polystyrene process (d) sand casting (e) shell molding (☻) slush casting?

14. Which of the following metals would typically be used in die casting (three best answers); (☻) aluminum (b) cast iron (c) steel (☻) tin (e) tungsten (☻) zinc?

15. Most sheet metalworking operations a performed as which of the following; (☻) cold working (b) hot working (c) warm working?

16. Which of the following are the two main functions of a cutting fluid in machining (two best answers); (a) improve surface finish on the workpiece (b) reduce forces and power (c) reduce friction at the tool-chip interface (☻) remove heat from the process(☻) wash away chips?
17. Shell molding is which one of the following: (a) casting operation in which the molten metal has been poured out after a thin shell has been solidified in the mold. (b) Casting operation used to make artificial sea shell. (c) casting process in which the mold is a thin shell of sand binded by a thermosetting resin. (d) sand-casting operation in which the pattern is a shell rather than a solid form.

18. Which die casting machines usually have a higher production rate; (a) cold-chamber casting. (b) hot-chamber casting. (c) shell casting. (d) sand casting.

19. Which of the basic bulk deformation processes use compression to effect shape change (three correct answers); (a) extrusion (b) rolling (c) forging (d) drawing

20. Which one of the following types of stress-strain relationship best describes the behavior of most metals at room temperature; (a) elastic and perfect plastic (b) elastic and strain hardening (c) perfectly elastic.

21. Which one of the following types of stress-strain relationship best describes the behavior of most metals at hot forming; (a) elastic and perfect plastic (b) elastic and strain hardening (c) perfectly elastic.

22. __________ is a procedure in which an unknown quantity is compared to a known standard, using an accepted and consistent system of units. (a) Calibration. (b) Measurement. (c) Inspection. (d) non of these.

Q2/

a) What are meant by the following terms (only five):

(1) **Core:** Patterns define the external shape of the cast part. If the casting is to have internal surfaces, a core is required. A core is a full-scale model of the interior surfaces of the part. It is inserted into the mold cavity prior to pouring, so that the molten metal will flow and solidify between the mold cavity and the core to form the casting’s external and internal surfaces. The core is usually made of sand, compacted into the desired shape. As with the pattern, the actual size of the core must include allowances for shrinkage and machining.

(2) **Slush casting:** Slush casting is a permanent mold process in which a hollow casting is formed by inverting the mold after partial freezing at the surface to drain out the liquid metal in the center. Solidification begins at the mold walls because they are relatively cool, and it progresses over time toward the middle of the casting. Thickness of the shell is controlled by the length of time allowed before draining. Slush casting is used to make statues, lamp pedestals, and toys out of low melting point metals such as lead, zinc, and tin. In these items, the exterior appearance is important, but the strength and interior geometry of the casting are minor considerations.

(3) **Bulk deformation:** Bulk Deformation Processes such as rolling and forging: Are generally characterized by significant deformations and massive shape changes, and the surface area-to-volume of the work is relatively small. The term bulk describes the workparts that have this low area-to-volume ratio.

(4) **Inspection:** Is a procedure in which a part or product characteristic, such as a dimension is examined to determine whether it conforms to the design specification. Many: inspection procedures rely on measurement techniques, while others use gauging methods. Gauging determines simply whether the part characteristic meet or does not meet the design specification whether the part passes or fails inspection. It is usually faster than measuring, but scant information is provided about the actual values of the characteristic of interest.
(5) **built-up edge**: Friction between tool and chip tends to cause portions of workpiece material to adhere to the rake face of the tool near the cutting edge. This formation called a built-up edge.

(6) **squeeze casting**

(7) **arc welding**: Arc welding (AW) is a fusion-welding process in which coalescence of the metals is achieved by the heat from an electric arc between an electrode and the work. An electric arc is a discharge of electric current across a gap in a circuit. It is sustained by the presence of a thermally ionized column of gas (called a plasma) through which current flows. To initiate the arc in an AW process, the electrode is brought into contact with the work and then quickly separated from it by a short distance. The electric energy from the arc thus formed produces temperatures of 5500°C or higher, sufficiently hot to melt any metal. In most arc-welding processes, filler metal is added during the operation to increase the volume and strength of the weld joint.

**b) What are the disadvantages associated with turning processes?**

Certain disadvantages are associated with machining and other material removal processes:

- Wasteful of material. Machining is inherently wasteful of material. The chips generated in a machining operation are wasted material. Although these chips can usually be recycled, in terms of the unit operation, the material that is removed is waste.
- Time consuming. A machining operation generally takes more time to shape a given part than alternative shaping processes such as casting or forging.

Q3/

a) **What is the fundamental difference between a fusion weld and a solid-state weld?**

**Fusion Welding**: Fusion welding processes use heat to melt the base metals. In many fusion welding operations, a filler metal is added to the molten pool to facilitate the process and provide bulk and strength to the welded joint. The fusion category includes the most widely used welding processes, which can be organized into the following general groups such as arc welding and resistance welding.

**Solid-State Welding**: Refers to joining processes in which coalescence results from application of pressure alone or a combination of heat and pressure. If heat is used, the temperature in the process is below the melting point of the metals being welded. No filler metal is utilized. Some representative welding processes in this group include: Diffusion welding Friction welding and Ultrasonic welding.

b) **How can you tell whether a certain part is done in turning or milling operation?**

Machined parts can be classified as rotational or nonrotational. A rotational workpart has a cylindrical or disk-like shape. The characteristic operation that produces this geometry is one in which a cutting tool removes material from a rotating workpart. Examples include turning. A nonrotational (also called prismatic) workpart is block-like or plate-like. This geometry is achieved by linear motions of the workpart, combined with either rotating or linear tool motions. Operations in this category include milling.

c) **List the advantages and limitations of shell casting? Draw steps in shell molding?**[10D]

**Shell Casting**: Is a casting process in which the mold is a thin shell (typically 9 mm) made of sand held together by a thermosetting resin binder. The process is described and illustrated in Fig. (bellow).
There are many advantages to the shell-molding process. The surface of the shell mold cavity is smoother than a conventional greensand mold, and this smoothness permits easier flow of molten metal during pouring and better surface finish on the final casting. Finishes of 2.5 µm can be obtained. Good dimensional accuracy is also achieved, with tolerances of ±0.25 mm possible on small-to-medium-sized parts. The good finish and accuracy often precludes the need for further machining. collapsibility of the mold is generally sufficient to avoid tearing and cracking of the casting.

Disadvantages of shell molding include a more expensive metal pattern than the corresponding pattern for green-sand molding. This makes shell molding difficult to justify for small quantities of parts. Shell molding can be mechanized for mass production and is very economical for large quantities. It seems particularly suited to steel castings of less than 20 lb. Examples of parts made using shell molding include gears, valve bodies, bushings, and camshafts.

![Diagram of the shell-molding process](image)

**Fig.(4) Steps in shell-molding:** (1) a match-plate or cope-and-drag metal pattern s heated and placed over a box containing sand mixed with thermosetting resin; (2) box is inverted so that sand and resin fail onto the hot pattern, causing a layer of the mixture to partially cure on the surface to form a hard shell; (3) box is repositioned so that loose, uncured particles drop away; (4) sand shell is heated in oven for several minutes to complete curing; (5) shell mold is stripped from the pattern; (6) two halves of the shell mold are assembled, supported by sand or metal shot in a box, and pouring is accomplished. The finished casting with sprue removed is shown in (7).

**Q4/ a) How does sheet-metal forming differ from rolling and forging? [3D]**

**Bulk Deformation Processes** such as rolling and forging: Are generally characterized by significant deformations and massive shape changes, and the surface area-to-volume of the work is relatively small. The term bulk describes the workparts that have this low area-to-volume ratio.

Sheet metalworking processes are forming and related operations performed on metal sheets, strips, and coils. The surface area-to-volume ratio of the starting metal is high; thus, this ratio is a useful means to distinguish bulk deformation from sheet metal processes.
b) Select proper letter in the opposite table; [17D]

<table>
<thead>
<tr>
<th></th>
<th>Type of chip</th>
<th>The Answer</th>
<th>Type of material being machined and the cutting conditions of the operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Continuous chip</td>
<td>1 D</td>
<td>A cast irons are machined at low cutting speeds</td>
</tr>
<tr>
<td>2</td>
<td>Discontinuous chip</td>
<td>2 A</td>
<td>B ductile materials at low-to-medium cutting speeds</td>
</tr>
<tr>
<td>3</td>
<td>Continuous chip with built-up edges</td>
<td>3 B</td>
<td>C titanium alloys machined at higher cutting speeds</td>
</tr>
<tr>
<td>4</td>
<td>Serrated chips</td>
<td>4 C</td>
<td>D ductile work materials are cut at high speeds and relatively small feeds and depths</td>
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<thead>
<tr>
<th></th>
<th>Casting Process</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sand</td>
<td>1 B A Equipment is expensive; part shape limited.</td>
</tr>
<tr>
<td>2</td>
<td>Plaster mold</td>
<td>2 D B Some finishing required; somewhat coarse finish; wide tolerances.</td>
</tr>
<tr>
<td>3</td>
<td>Centrifugal</td>
<td>3 A C mold cost is high; part size limited; usually limited to nonferrous metals; long lead time.</td>
</tr>
<tr>
<td>4</td>
<td>Die</td>
<td>4 C D Limited to nonferrous metals; limited size and volume of production; mold making time relatively long.</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th></th>
<th>Casting Process</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sand</td>
<td>1 D A Good dimensional accuracy and surface finish; high production rate.</td>
</tr>
<tr>
<td>2</td>
<td>Shell mold</td>
<td>2 C B Large cylindrical parts with good quality; high production rate.</td>
</tr>
<tr>
<td>3</td>
<td>Centrifugal</td>
<td>3 B C Excellent dimensional accuracy and surface finish; high production rate</td>
</tr>
<tr>
<td>4</td>
<td>Die</td>
<td>4 A D Almost any metal cast; no limit to size, shape or weight; low tooling cost</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th></th>
<th>Casting Defects</th>
<th>Caused by</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Misruns</td>
<td>1 E A Solidification shrinkage that restricts the amount of molten metal available in the last region to freeze.</td>
</tr>
<tr>
<td>2</td>
<td>Cold Shots</td>
<td>2 C B Localized solidification shrinkage of the final molten metal in the dendritic structure.</td>
</tr>
<tr>
<td>3</td>
<td>Hot tearing</td>
<td>3 D C Splattering during pouring</td>
</tr>
<tr>
<td>4</td>
<td>Microporosity</td>
<td>4 B D The metal’s inability to shrink naturally.</td>
</tr>
<tr>
<td>5</td>
<td>Shrinkage cavity</td>
<td>5 A E (1) fluidity of the molten metal is insufficient, (2) pouring temperature is too low, (3) pouring is done too slowly, and/or (4) cross section of the mold cavity is too thin.</td>
</tr>
</tbody>
</table>

Q5/ Correct the wrong sentences if found: [20D]

1. **Metal forming applies stresses that exceed the ultimate strength of the metal.**
   *Metal forming applies stresses that exceed the yield strength of the metal.*

2. **In hot forming the strength coefficient **$K = \sigma_y$, and strain hardening exponent, $n = 1$.**
   *In hot forming the strength coefficient **$K = \sigma_y$, and strain hardening exponent, $n = 0$.***

3. **Desirable properties for forming include high yield strength and low elongation or area reduction.**
   *Desirable properties for forming include low yield strength and high elongation or area reduction.*
4. The plastic region of the stress-strain curve for a metal characterized by a proportional stress and strain.

5. Knurling is performed on a lathe, but it is a metal forming operation rather than a metal removal operation.

6. Aluminum is element added to improve the chip formation and to easier machining properties of steel.

7. Drawing is a compression process in which the work metal is forced to flow through a die opening, thereby taking the shape of the opening as its own cross-section.

8. Disadvantages of hot rolling are that the product cannot be held to close tolerance, and surface has a characteristic oxide scale.

9. A lathe is normally used to perform milling operation.

10. Contraction during the phase change from liquid to solid, called liquid shrinkage.

11. In sand casting, the volumetric size of the pattern is smaller relative to the casting.

12. Hot forming of metals involves deformation at temperature above the recrystallization temperature, about 0.1Tm of its melting point on the absolute scale.

13. Friction between tool and chip tends to cause portions of tool material to adhere to the rake face of the tool near the cutting edge. This formation called a built-up edge.

14. Depth of cut, is one of the cutting condition which has the strongest effect on ideal and natural surface roughness.

15. As the cutting speed increased, the surface finish improves until at the higher speeds it approaches the ideal value for the chosen conditions of tool shape and feed.

16. Drilling, turning, and milling use rotating multiple cutting-edge tool

Q6/ Point to the drawing details illustrated below:[20D]
a) Cold chamber die-casting:

![Diagram of cold chamber die-casting]

b) Machining operations other than turning that are performed on a lathe. Fig. (below): (a) facing (b) taper turning (c) contour turning (d) form turning (e) chamfering (f) cutoff, (g) threading (h) boring (I) drilling, and (j) knurling.

![Diagram of machining operations]

c) Three categories of stress-strain relationship: (a) perfectly elastic (b) elastic and perfectly plastic (c) elastic and strain hardening.

![Diagram of stress-strain relationship]