1. **Explain the fundamental principles of machining or metal cutting.** Your answer should detail what occurs in the "primary shear zone" and the phenomenon of "secondary shear". Additionally, differentiate between the three main types of chip formation – continuous, discontinuous, and continuous with a built-up edge – by describing the specific cutting conditions and workpiece material characteristics that lead to each type.
2. **Compare and contrast Conventional Machining with Non-Conventional Machining processes.** Your answer should include their definitions, primary energy sources, suitability for different materials, and their respective advantages and limitations. Provide at least two specific examples for each category, naming the energy form utilized in the non-conventional examples.
3. **Describe the detailed construction and primary functions of the typical parts of a Lathe machine.** Your answer should cover the "Bed" (including its material and guideways), "Headstock" (its contents and power distribution), and "Tailstock" (its movability and versatility). Subsequently, explain the roles of the "Cross Slide," "Compound Rest," and "Tool Post" within the "Carriage Assembly," highlighting how each contributes to tool movement and positioning.
4. **Explain various operations performed on a Lathe machine.** Focus on "Plain Turning," "Facing," and "Thread Cutting". For each, describe its purpose, the characteristic surface it generates, and how the relative motions between the tool and workpiece are achieved. In the context of thread cutting, explain how the axial movement of the tool in relation to workpiece rotation determines the thread pitch.
5. **Discuss the different methods for Taper Turning on a Lathe.** Explain at least three distinct methods, such as "using form tools," "swiveling the compound rest," and "offsetting the tailstock," or "using a taper turning attachment". For each method, describe its principle of operation, its suitability for different taper characteristics (e.g., length, steepness), and any notable advantages or disadvantages.

6. **Analyze the process of estimating Machining Time in turning operations.** Explain the importance of selecting proper process parameters and how cutting speed (V) is defined and calculated. Detail the formula for calculating the time (t) required for a single pass, defining all its variables. Furthermore, discuss the factors that determine the number of roughing and finishing passes needed, providing their respective formulas.
7. **Describe the Drilling operation and the Twist Drill tool.** Explain the fundamental mechanism of drilling and how the workpiece is typically held and the tool moved. Detail the two main parts of a twist drill and the dual functions of its spiral flutes. Subsequently, explain "Reaming" and "Boring" as related hole-making operations, highlighting their specific purposes and how they differ from each other.
8. **Explain the types of drilling machines and their typical applications.** Focus on the "Radial Drilling Machine" and the "Gang Drilling Machine". For each, describe its characteristic features and why it is suited for particular production scenarios (e.g., large workpieces or volume production).
9. **Discuss the operation of "Tapping" and "Counterboring" in machining.** For tapping, explain its purpose and the type of tool used. For counterboring, describe its objective, the typical features of its tool (including the pilot portion), and how its speeds and feeds compare to drilling. Also, briefly explain "Countersinking" by differentiating it from counterboring.
10. **Describe the fundamental principles of Milling as a metal cutting process.** Explain how it differs from a lathe operation in terms of tooling. Categorize milling operations into "Peripheral Milling" and "Face Milling," outlining the orientation of the generated surface relative to the cutter axis in each case.
11. **Compare and contrast Horizontal Milling Machines and Vertical Milling Machines.** Your answer should detail their differences in spindle orientation, cutter movement capabilities (e.g., up and down), cutter mounting, and the ability to tilt the spindle for angular cutting. Provide examples of typical operations performed on each type of machine.

12. **Explain the concepts of "Up Milling (Conventional Milling)" and "Down Milling (Climb Milling)."** Describe how the direction of the cutting tool's rotation relates to the table movement (feed direction) in each. Discuss the implications of these directions on the cutting forces and how they affect the workpiece stability.
13. **Describe at least three specific types of Milling operations (excluding Peripheral and Face milling as broad categories).** You may choose from Slab Milling, Slotting, Side Milling, Straddle Milling, Form Milling, Angular Milling, End Milling, Profile Milling, Pocket Milling, or Surface Contouring. For each chosen operation, provide its definition and a key characteristic or application.
14. **Explain what constitutes a Manufacturing System and its broad components.** Discuss the different categories of "Production machines" (manually operated, semi-automated, fully automated) and the objectives of a "Material Handling System".
15. **Discuss Numerical Control (NC) as a form of programmable automation.** Explain its definition, its principal application, and detail its three basic components: "Program of Instruction," "Controller Unit," and "Machine Tool". Conclude by outlining the major limitations or drawbacks of conventional NC systems.
16. **Explain Computer Numerical Control (CNC) and how it fundamentally differs from conventional NC systems.** Describe at least four distinct features associated with a CNC system. Additionally, explain at least two of the common CNC programming methods (e.g., Manual Part Programming, Computer Assisted Part Programming, CAD/CAM, Conversational, Parametric).
17. **Discuss the advantages of a CNC System.** Provide a comprehensive explanation of how CNC machines contribute to increased precision and accuracy, enhanced flexibility and adaptability, higher automation and efficiency, reduced labor costs, improved consistency and quality, and effective prototyping.
18. **Explain the concept of CNC Machining Centres.** Describe what they are and categorize them into "Vertical Axis Machining Centres (VMC)" and "Horizontal Axis Machining Centres (HMC)". For each category, discuss its key

characteristics, suitability for different types of workpieces or metal removal rates, and aspects related to tooling.

19. **Define Additive Manufacturing and explain its core principle.** Discuss how it is viewed in relation to digital models and its broad impact on new manufacturing opportunities. List at least three diverse domains where additive manufacturing and 3D printing are currently used or researched.
20. **Describe the Material Extrusion process, specifically Fused Deposition Modelling (FDM).** Explain the fundamental mechanism of how parts are fabricated in FDM. Detail the four key stages of the FDM process: "Part preparation," "FDM Machine setup," "FDM printing," and "FDM part removal," explaining the activities involved in each.
21. **Explain the concept of Unconventional Machining Processes (UCM)**. What distinguishes them fundamentally from conventional machining, and for what types of materials and profiles are they typically used? List at least five "main characteristics" of UCM processes.
22. **Describe the principle of operation for Abrasive Jet Machining (AJM)**. Explain how material removal occurs and what materials are most suitable for this method. Provide details on the carrier medium and types of abrasive particles used, including their typical sizes and jet velocities. List at least three specific applications of AJM.
23. **Discuss the advantages and limitations of Abrasive Jet Machining (AJM)**. Include aspects like capital investment, suitability for brittle materials, heat generation, tool contact, metal removal rate, machining accuracy, and reusability of abrasive powder.
24. **Explain the principle of operation of Electron Beam Machining (EBM).** Describe the thermal nature of the process and how material removal (melting/vaporization) occurs. Detail the components of the electron gun, how the beam is shaped, accelerated, and focused, and the critical role of a vacuum environment.
25. **Analyze the advantages and disadvantages of Electron Beam Machining (EBM).** Your answer should cover aspects such as burr production, heat-affected

zone, machining stresses, speed, precision, cost, and environmental requirements.

26. **Define Heat Treatment and its purpose in mechanical engineering.** Explain how it controls mechanical properties. Describe the "Normalizing" process in detail, including heating/cooling parameters, its purposes (e.g., grain refinement, stress removal), and the resulting microstructure in hypoeutectoid and hypereutectoid steels.
27. **Explain the "Annealing" heat treatment process.** Discuss its general purposes (e.g., softening, ductility, stress removal). Differentiate between "Process Annealing" and "Full Annealing," describing the specific heating and cooling steps and the distinct purposes of each type.
28. **Describe the "Tempering" heat treatment process.** Explain its definition, how it alters the microstructure (e.g., martensite transformation), and its primary purposes. Detail the characteristics and applications of "Low Temperature Tempering," "Medium Temperature Tempering," and "High Temperature Tempering".
29. **Explain "Carburizing" as a case hardening process.** Describe the fundamental principle of how carbon is absorbed and how this affects the hardness of the outer surface versus the core. Differentiate between "Gas Carburizing" and "Pack Carburizing" in terms of the carbon-rich atmosphere and mechanism of carbon transfer.
30. **Discuss the concepts of "Open Loop" and "Closed Loop" control systems.** Provide clear explanations for each, using practical examples to illustrate the presence or absence of a feedback mechanism. Subsequently, identify and explain the function of the five basic elements of a generic closed-loop control system, including the "error signal" calculation.