Department of Aerospace Engineering

19AST202 AIRCRAFT PRODUCTION TECHNOLOGY

UNIT III POWDER METALLURGY AND **UNCONVENTIONAL MACHINING**

UNCONVENTIONAL MACHINING

1	**Explain briefly 'Water Jet Machining'.** Ans. In 'Water Jet Machining' process a high velocity *water jet* is made to impinge on to the workpiece. This jet pierces the work material and performs a sort of slitting operation. Water under pressure from a hydraulic accumulator is passed through the orifice of a nozzle to increase its velocity. The nozzle orifice size (dia.) usually varies from 0.08 mm to 0.5 mm and the exit velocity of the water jet from the nozzle varies upto 920 m/s. These high velocity jets can be used to cut relatively softer and non-metallic materials like paper boards, wood, plastics asbestos, rubber, fireglass, leather etc. _ A variation of this process known as ''*Hydrodynamic Jet Machining (HJM)*'' has been successfully used to machine almost all types of ferrous and non-ferrous metals and alloys.
2	**On what types of works the process of chemical machining is best suited and what are its advantages and limitations ?** Ans. __Chemical machining is an excellent method of getting complex shapes on very thin and most difficult to machine tools. _ It does not require any press or punch or die. It does not distort the workpiece and no burrs are produced. _ It is a *slow process* and thus limited to machining metals upto 3 mm thickness and not used for producing large quantities.
3	**What is 'hot machining' ?** Ans. 'Hot Machining' is used for machining high strength, high hardness and high temperature resistant materials which are difficult to machine at room temperature. Machining of hard metals at elevated temperature is applied mainly to turning and milling operations. Since the shear strength of metal decreases at elevated temperature as compared to that at room temperature the magnitude of the cutting forces on the tool is lower. Further as the chip formation by plastic deformation in the shear plane ahead of tool becomes easier at elevated temperature and cutting forces involved are less, therefore power requirements are low. But as the property of tool material at elevated temperature is also changed due to its being in contact with high temperature material, therefore tool life is also affected. It is found that tool life is maximum for certain temperature of workpiece (for particular work material and tool material) at which total metal removal rate per tool grinding will be maximum irrespective of the speed.
4	**For what purpose Electric Discharge Machines (EDM) are used ?** **Ans.** EDM machines are used for avoiding difficulty to machine materials through the use of electric spark. *Example :* Die sinking or removal of broken tools embedded in workpieces
5	**Indicate the sources of energy in the following processes :** ***(a)*** **EDM, (*b*) USM, (*c*) LBM, (*d*) ECM.**

	Ans. ***Process*** ***Sources of energy*** (*a*) EDM *Electric spark* (*b*) USM *Mechanical* (*c*) LBM *Radiation* (*d*) ECM *Electrical*
6	**What do you understand by the terms ‘‘Unconventional or Non-traditional machining methods? What is their importance ?** Unconventional or non-traditional machining methods refer to a group of manufacturing processes that are used to remove material from a workpiece using methods other than traditional mechanical, thermal, or chemical processes. These methods are employed when traditional machining techniques are not feasible or efficient for the particular material, shape, or application requirements. Examples of unconventional machining methods include electrical discharge machining (EDM), laser cutting, water jet cutting, and abrasive jet machining, among others. The importance of unconventional machining methods lies in their ability to effectively machine complex shapes, hard materials, and delicate components that cannot be easily machined using conventional techniques. These methods allow for precise and intricate machining, offering advantages such as: Machining of Hard Materials: Unconventional machining methods can effectively handle materials with high hardness, such as hardened steels, carbides, and ceramics, which are difficult to machine using traditional methods. Complex Geometries: They enable the machining of intricate and complex shapes, including internal features and intricate contours, which are challenging to produce with conventional machining processes. Reduced Heat Affected Zone: Unconventional machining methods often produce minimal heat-affected zones, reducing the risk of thermal damage to the workpiece, which is crucial for materials sensitive to heat, such as heat-treated metals or certain plastics. Minimal Tool Wear: These methods often result in reduced tool wear compared to traditional machining processes, leading to longer tool life and lower production costs. Versatility: Unconventional machining methods offer versatility in machining various materials, including conductive and non-conductive materials, which may not be suitable for conventional machining techniques
7	**How are ‘Unconventional machining methods’ classified ?** Unconventional machining methods are classified based on the principle of energy used for material removal. The classification is typically as follows: Electrical Energy-Based Methods: This category includes processes that utilize electrical energy for material removal. Examples include Electrical Discharge Machining (EDM) and Electrochemical Machining (ECM). EDM employs electrical discharges for material removal, while ECM uses the principle of electrolysis for machining. Thermal Energy-Based Methods: These methods utilize thermal energy for material removal. Techniques such as Laser Beam Machining (LBM) and Electron Beam Machining (EBM) fall under this category. LBM employs a high-power laser beam for material removal, while EBM uses a focused electron beam for machining. Chemical Energy-Based Methods: Processes that utilize chemical energy for material removal are classified under this category. Chemical Machining (CHM) and Electrochemical Machining (ECM) are examples of this group. CHM involves selective chemical etching of material, while ECM uses electrolysis for material removal. Mechanical Energy-Based Methods: This classification includes processes that utilize mechanical energy for material removal. Examples include Ultrasonic Machining (USM) and Water Jet Machining (WJM). USM utilizes ultrasonic vibrations for machining, while WJM employs a high-velocity stream of water for material removal. Hybrid Processes: These methods combine the principles of two or more unconventional machining methods to achieve specific machining goals. Hybrid processes aim to leverage the advantages of multiple techniques to overcome the limitations of individual methods and enhance overall machining efficiency and accuracy.
8	**What is ‘‘Electrical Discharge Machining (EDM)’’ ? Explain its principle with the help of a suitable diagram.**

9	**State the advantages, disadvantages and applications of EDM.**
10	**Explain with a neat sketch the principle and working of Electro-chemical Machining (ECM) process.**
11	**Give the important characteristics of ECM.** **Electrochemical Machining (ECM) is a non-traditional machining process that uses the principle of electrolysis to remove material from conductive workpieces. ECM offers several important characteristics that make it suitable for specific manufacturing applications. Some of the key characteristics of ECM include:** **1. Precise and Complex Machining: ECM can achieve high levels of precision and is capable of machining intricate and complex shapes, including internal cavities, intricate contours, and difficult-to-access areas.** **2. Minimal Tool Wear: ECM typically results in minimal tool wear, enabling longer tool life and reducing the need for frequent tool replacements, leading to cost savings in the production process.** **3. No Thermal Damage: As ECM is a non-thermal process, it generates minimal heat, thereby eliminating the risk of thermal damage to the workpiece. This characteristic is particularly beneficial for materials sensitive to heat and for maintaining the integrity of heat-treated components.** **4. Suitable for Hard Materials: ECM is effective for machining materials with high hardness, including hardened steels, superalloys, and titanium, which are difficult to machine using conventional methods, making it a valuable process in the aerospace and automotive industries.** **5. High Surface Finish: ECM can achieve a high-quality surface finish, producing smooth surfaces with no residual stresses, burrs, or microcracks, making it suitable for applications where surface integrity is critical.** **6. Minimal Deformation: The process of ECM results in minimal workpiece deformation, allowing for the production of components with precise dimensional accuracy and shape consistency.** **7. No Material Limitation: ECM can be applied to various conductive materials, including metals, alloys, and some semiconductors, making it a versatile machining method for a wide range of industrial applications.**
12	**Describe briefly 'Electro-Chemical Grinding' process. State also its advantages, disadvantages and applications.**
13	**Explain briefly with a neat sketch the principle and working of Ultrasonic machining (USM) process/ method. List also its advantages, disadvantages and applications.**
14	**What is the working principle of Electron Beam Machining (EBM) ? What are its advantages, disadvantages and applications ?**
15	**Describe briefly with a neat diagram the working principle of Laser Beam Machining (LBM) ? Give also its advantages, disadvantages and applications.**
16	**Explain clearly, with a neat diagram, Abrasive Jet Machining (AJM) method. State also its advantages, disadvantages and applications.**