Assignment-1

1) Discuss and explain the difference between conventional machining and non-conventional machining process.

-> Conventional Machining	Non-Conventional Machining
* Uses hard cutting tool to remove excess material.	* Utilizes various forms of energy sources to remove excess material.
* This process involves direct contact between tool and workpiece.	* No physical contact between tool and workpiece.
* Tool life is less	* Tool life is comparatively more
* Difficult to obtain high accuracy and surface finish	* NTM result in high accuracy and surface finish.
* Metal removal rate is limited	* No such limitations
* Require skilled or unskilled labour	* Require skilled labour.
* Low capital cost.	* comparatively higher cost.
* Easy setup equipment	* Complex setup.
* Process is noisy	* process is quieter in operation.
* Chip handling and storage is a problem.	* Chip handling and storage is not a problem.

2) Discuss the classification of NTM processes based on type of energy used (eg. mechanical, thermal, chemical, electrical). Provide examples for each category.

-> Classification of NTM Processes:

NTM processes are typically classified based on nature of energy employed in machining.

1) Mechanical energy:

The excess material is removed by mechanical erosion of the workpiece material. The various machining processes that utilize mechanical energy include.

* ultrasonic machining (USM)
* water jet machining (WJM)
* Abrasive jet machining (AJM)

2) Chemical or electrochemical energy:

The material is removed from the workpiece by ion displacement or by chemical dissolution using chemical reagents like acids and alkaline solution

* Electrochemical machining (ECM)
* Electrochemical Honing (ECH)
* Chemical maching (CM)
* Electrochemical grinding [ECG]

3) Thermal or electrothermal energy

Thermal energy is employed to melt and vaporize tiny bits of workpiece by concentrating the heat energy on a small area of workpiece

* Laser beam machining (LBM)
* Electrical discharge machining (EDM)
* Plasma arc machining (PBM)
* Ion beam machining (IBM)
* Electron beam machining (EBM)

3) Analyse a case study analysis of a specific NTM process used in an industry of your choice. Discuss the process, its advantages, limitations and need for its selection.

→ Electrical DisCharge Machining (EDM) is a thermal erosion process where material is removed from a conductive workpiece by a series of controlled electrical discharge between an electrode and the workpiece, both submerged in a dielectric fluid.

Industrial application: Aerospace

Advantages: * Machining of hard materials
* No mechanical stress
* High Precision and Surface finish
* Ability to produce intricate shapes.

Limitations : * Limited to conductive materials

* Slow MRR
* Tool wear is high
* Thermal damage

The selection of EDM for aerospace applications is based on functional and material-specific requirements.

* Material hardness
* dimensional accuracy
* Complex geometry
* Stress-Free Machining

4) Glass is being machined at a MRR of 6 mm^3/min by Al_2O_3 abrasive grits at a frequency of 20kHz, if the frequency is increased to 25 KHz, what would be the MRR.

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$$\frac{MRR_2}{MRR_1} = \frac{f_2}{f_1}$$

$$\therefore \frac{MRR_2}{6} = \frac{25}{20}$$

$$MRR_2 = 6 \times \frac{25}{20}$$

$$MRR_2 = 6 \times 1.25 = 7.5\ mm^3/min$$

5) Discuss and explain types of tool feed system used in ultrasonic machining.

→ Feed system is used to apply the static load between the tool and workpiece during ultrasonic machining operation. There are three types of feed mechanism used in USM

* Gravity feed mechanism: In this mechanism counter weights are used to apply the load to the transducer head through a pulley. In order to reduce the friction ball bearings are used. Gravity feed mechanism is generally preferred because of simple construction.

* Spring Loaded feed mechanism: In this mechanism spring pressure is used to feed the tool during machining operation. This type of mechanism is also preferred because of its sensitive and compactness.

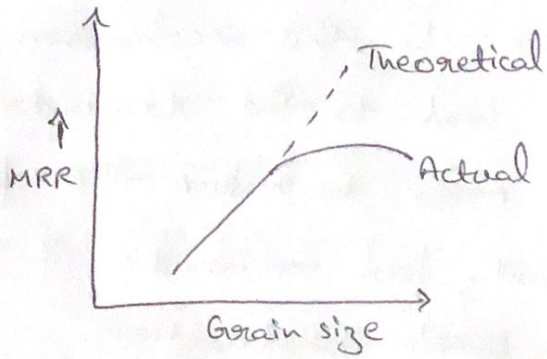
* Pneumatic or hydraulic feed mechanism: In this mechanism compressed air is passed in a pneumatic cylinder and the feed is fed by the reciprocating action of the piston inside the cylinder. Pneumatic feed mechanism is used in order to get high feed rate.

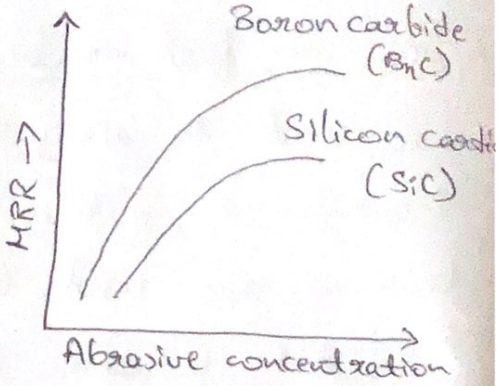
6) Explain the effects of process parameters on ultrasonic machining.

→ Material Removal rate: (MRR)

MRR in USM depends on

* workpiece * Tool * Slurry





Tool wear: Tool wear is a crucial factor affecting machining efficiency in USM.

* Tool flexibility: Flexible tools materials reduce abrasive wear.
* Machining Time: Tool wear increases time
* Static Load and depth: Tool wear is highest at certain loads.

Accuracy: * Dimensional accuracy: Precision of the machine, tool wear, abrasive size and cut depth all influence how close the final part is to the intended dimensions.

Surface finish: * Abrasive size: Smaller abrasive grains provide a smoother surface by removing finer particles of material.

* Tool material: A tool with a smooth surface and higher hardness will produce a smoother finish on the workpiece.

7) Explain with a neat sketch, the principle and working of Electrochemical machining (ECM) Process.

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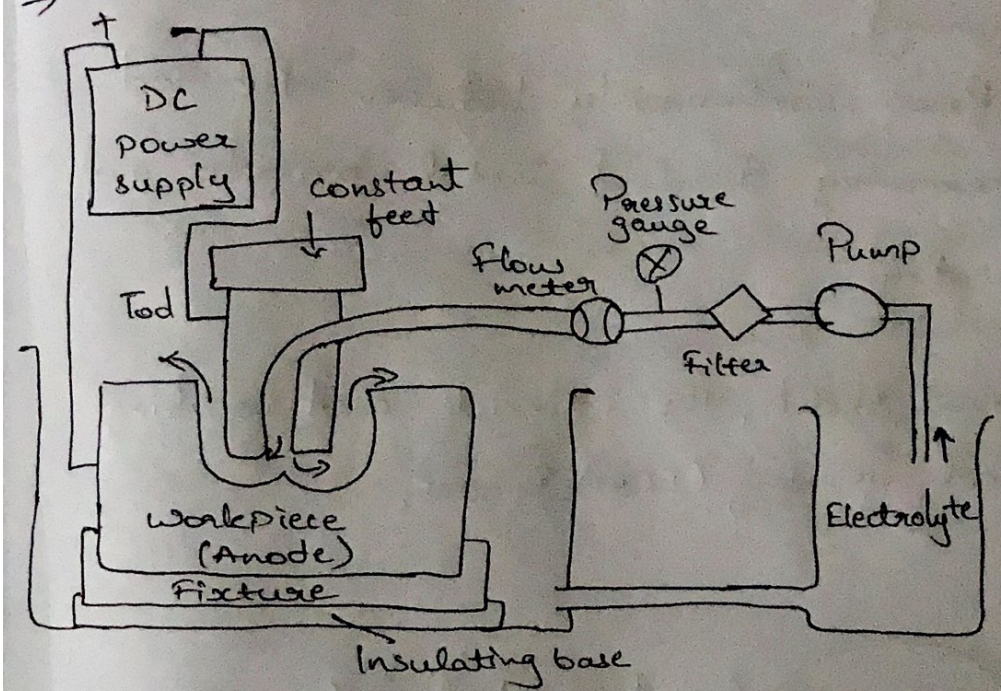

* ECM is often compared to reverse electroplating. Instead of adding material to a surface, ECM removes material.
* A high electric current is passed between tool (cathode) and workpiece (anode) both immersed in an electrolyte solution.
* This causes metal atoms to dissolve from the workpiece, replicating the shape of the tool

Working: The workpiece is securely held, and both the tool and workpiece are immersed in an electrolyte solution (usually NaCl)

* Direct current (DC) is applied: the tool (cathode) is connected to the negative terminal, and the workpiece (anode) to positive terminal.
* The electrolyte flows continuously between the tool and workpiece, removing dissolved metal particles and preventing overheating.

8) Explain with a neat sketch, the principle and working of electro chemical grinding (ECG) Process.

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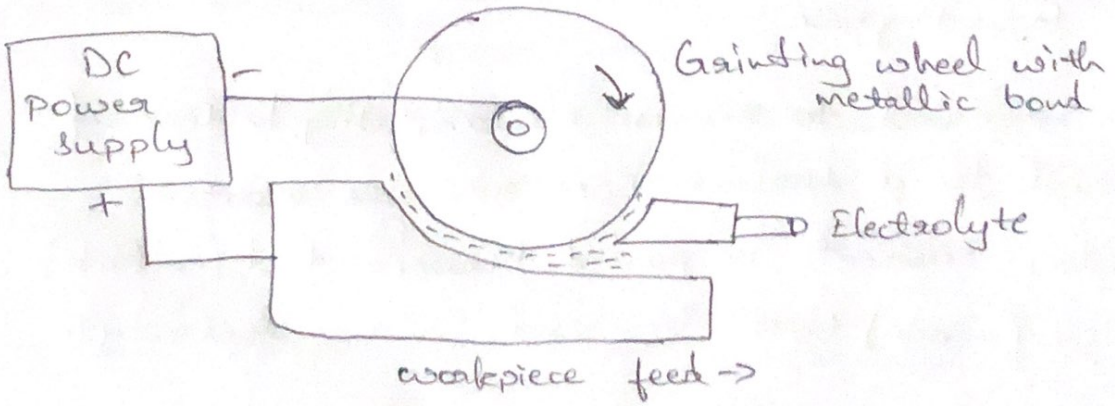

* Electrochemical Grinding (ECG) is a hybrid machining process that combines electrochemical machining (ECM) with conventional grinding. This process is used to remove material from electrically conductive workpiece.

Working: In ECG, the metal removal occurs through the combined effect of electrochemical dissolution (around 90%) and mechanical abrasion (around 10%). The grinding wheel acts as the cathode and the workpiece as the anode, both submerged in an electrolyte solution. As the electric current passes through the electrolyte, electrochemic reactions occurs and metal is dissolved from the workpiece. The grinding wheel removes the oxides and loose particles generated during electrochemical dissolution, maintaining a smooth surface.