DEPARTMENT OF MECHANICAL ENGG.|UNCONV ENTIONAL MACHINING PROCESS – III-YEAR (6th SEMESTER)

UNIT -1

1. What is the need for unconventional machining processes?

High production rate
Low cost of production
Better surface integrity,
High surface finish

2. What are the characteristics of UCM processes?

- Performance is independent of strength barrier
- Use different kinds of energy in direct form
- In general, low MRR but better quality products
- Comparatively high initial investment cost

3.Differentiate the conventional and unconventional machining processes in terms of principles.
In conventional processes, the material is removed in the form of chips by the advancing cutting tool that plastically deforms (shearing) the material ahead. In the case of the UCM processes, energy (Electrical, Chemical, Thermo-Electric, Mechanical) in its direct form is utilized for the material removal and so there is no physical contact between the workpiece and tool.

4. What are the various types of energy sources used in non-traditional machining techniques? Give examples for each.

- ✓ Pneumatic pressure- AJM
- ✓ Hydraulic pressure- WJM, USM, AWJM
- ✓ Corrosion- CHM, CHB, PCM
- ✓ High current density in electrolytes- ECM
- ✓ High voltage- EDM (for sparking); IBM, EBM (ionizing); LBM (creating avalanche in lazing medium); PAM (for ionizing the plasma gases)

5. Classify the different types of unconventional machining processes based on the mechanical energy.

- ✓ Abrasive Jet Machining (AJM)
- ✓ Water Jet Machining (WJM)
- ✓ Ultrasonic Machining (USM)
- ✓ Abrasive Water Jet Machining (AWJM)

6. Identify the mechanism of material removal, transfer media and energy source for EDM.

Mechanism of material removal- Fusion of materials by arcs

Transfer media - Electron stream

Energy source - High voltage

7. Identify the mechanism of material removal, transfer media and energy source for ECM.
Mechanism of material removal- Ion displacement

Transfer media - Electrolyte

Energy source - High current

8. Identify the mechanism of material removal, transfer media and energy source for EBM.
Mechanism of material removal- Vaporization

Transfer media - Electron stream

Energy source - High voltage

9. Identify the mechanism of material removal, transfer media and energy source for LBM.
Mechanism of material removal- Vaporization

Transfer media - Amplified coherent light radiation

Energy source - High voltage

10. Identify the mechanism of material removal, transfer media and energy source for PAM. Mechanism of material removal- Vaporization

Transfer media - Ionised gas stream

Energy source - High voltage

11. Identify the mechanism of material removal, transfer media and energy source for USM. Mechanism of material removal- Erosion

Transfer media - High velocity particles

Energy source - Hydraulic pressure

12. Identify the mechanism of material removal, transfer media and energy source for AJM. Mechanism of material removal- Erosion

Transfer media - High velocity particles

Energy source - Pneumatic pressure

13. Identify the mechanism of material removal, transfer media and energy source for WJM. Mechanism of material removal- Erosion

Transfer media - High velocity water jet

Energy source - Hydraulic pressure

Unit – 2
Two Marks

1. What is the principle behind abrasive jet machining?

A jet of inert gas consisting of very fine abrasive particles strikes the work piece at high velocity (usually between 200-400 m/sec) resulting in material removal through chipping / erosive action.

2. What is the mechanism of material removal in AJM?

Erosion. Abrasive jet machining removes material through the action of a focused stream of abrasive-laden gas

3. What are the major subsystems of AJM?

AJM system consists of four major subsystems:

- Gas propulsion system
- Metering system
- Delivery system
- Abrasive collection system

4. Why the abrasive particles not reused in the AJM?

During the process, abrasive particles get contaminated with different gases used in the process, affecting their cutting efficiency; Also the cutting capacity decreases after the first application. Further, cost of the abrasive is also low.

5. Why is AJM not suitable for soft materials?

Abrasive particles used in AJM can penetrate and embed with soft materials.

6. Name the abrasive materials that are used for the AJM.
The common abrasives used for the AJM process are:

- Dolomite
- Sodium Bicarbonate
- Glass beads
- Silicon carbide
- Silicon Nitride
- Alumina

7. Mention the abrasives used for different applications

Abrasive	Application
Aluminium oxide	Cleaning, cutting and deburring
Silicon carbide	As above but for harder materials
Glass beads	Matt polishing, cleaning
Crushed glass	Peening, cleaning
Sodium bicarbonate	Cleaning, cutting for soft materials

8. Name different gases used in AJM. Which of this is most widely used?

- Dry air
- Carbon-di-oxide
- Nitrogen
- Helium

Air is most widely used owing to easy availability and little cost.

9. What is the effect of the grain size on the material removal rate (MRR) in the AJM?

Finer grain sizes are less irregular in shape, and hence, posses lesser cutting ability. Moreover, finer grains tend to stick together and choke the nozzle. The most favourable grain sizes range from 10 to 50μm. Larger particle sizes remove the material faster.

10. What is the effect of jet velocity on the MRR in AJM?

The kinetic energy of the abrasive jet is utilised for metal removal by erosion. The jet velocity is a function of the nozzle pressure, nozzle design, abrasive grain size and the mean number of abrasives per unit volume of the carrier gas. In general with increase in the jet velocity, the MRR increases.

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11. Define mixing ratio. What is the effect of mixing ratio on the MRR?

Mixing ratio is the ratio of the volume flow rate of the abrasive per unit time to the volume flow rate of the carrier gas per unit time. A large value of mixing ratio should result in higher rates of MRR but a large abrasive flow rate has been found to adversely influence jet velocity and may sometimes even clog the nozzle.

12. What is the effect of the abrasive powder flow rate on the MRR in AJM?

Increasing the flow rate increases the removal rate because more abrasive particles are available for cutting. However as the powder flow rate is increased, the mass fraction of abrasive in the jet is also increasing. As the mass fraction increases, the abrasive velocity decreases, thus reducing the removal rate.

13. What are common materials used for the nozzle in AJM?

Sapphire and tungsten carbide are the common materials for the nozzle.

14. Why are masks used in AJM? Which material is used for fabrication of masks?

Masks are used to control over spray or to produce large holes and intricate detail without having to move the nozzle and trace the shape. Masks can be fabricated from rubber or metal, each having its advantage and disadvantage. While the rubber masks are easy to fabricate, they give poor edge definition. The metal masks give much better definition but erode faster

15. Mention the process capabilities (process characteristics) of AJM

- Low MRR
- Intricate details can be produced
- Narrow slots
- Low tolerances
- Minimization of taper
- Thin-sectioned, brittle material, inaccessible areas
- Almost no surface damage

16. What are the advantages and limitations of AJM?

Advantages:

- Machining of very hard materials
- Heat sensitive materials can be machined – the gas stream dissipates generated heat when cutting heat-sensitive materials
- Fragile materials can be machined – the small loads transmitted to the workpiece allow the cutting of fragile pieces
- Very low capital cost and low power consumption
- No part shatter or vibration
- The nozzle can be directed towards small, difficult-to-reach areas

Limitations:

- Low material removal rate
- Stray cutting can occur and hence accuracy is not good
- Excessive taper on deep cuts may also be a disadvantage, although the amount of taper can be reduced by tilting the nozzle
- Short nozzle standoff when used for cutting
- Possibility of abrasive particles becoming embedded in the workpiece
- Nozzle wear rate is high
- Process tends to pollute the environment

17. Mention some typical applications of AJM in engineering.

- Removing flash and parting lines from injection moulded parts
- Deburring and polishing plastic, nylon and teflon components
- Cleaning metallic mould cavities which otherwise may be inaccessible
- Cleaning oxides from metal surfaces
- Cleaning metallic smears from ceramics

18. What s the principle of WJM?

If a jet of water is directed at a target in such a way that, on striking the surface, the high velocity flow is virtually stopped, then most of the kinetic energy of the water is converted into pressure energy. Erosion occurs when this pressure exceeds the strength of the bond binding together the materials making up the target.

19. What is the mechanism behind the material removal in WJM?

Removes material through the erosion effects of a high velocity, small diameter jet of water.

20. Name the main elements of the WJM system.

- Hydraulic unit
- Intensifier
- Accumulator
- Filters
- Water transmission lines
- On/off valve
- Waterjet nozzles
- Waterjet catchers
- Fluid additives

21. Why WJM is not suitable for brittle materials?

Brittle materials may crack and break during water jet machining.

22. Why is glass not machined by WJM?

Glass is a brittle material that cracks during WJM.

23. Why is it desirable to keep the standoff distance minimum in the WJM?

SOD is kept minimum in order to prevent the dispersion of water stream before it strikes the workpiece.

24. What are the process parameters that control the results achieved with WJM?

Pressure, nozzle diameter, traverse rate and the SOD, all define the process. Of these, SOD is the least critical.

25. What is the effect of traverse rate on the performance of WJM?

Thicker and denser materials can be cut as the traverse rate decreases. Materials that are too thick to be cut in a single pass can be cut with multiple passes if the first pass can produce a well-defined slot.

26. What is the function of intensifier in WJM?

The intensifier is used to increase the water pressure up to 380MPa – pressure increase is determined by the ratio of the working areas of the two cylinders.

27. What is the purpose of the accumulator in WJM?

Accumulator – also called as shock attenuator, is plumbed in parallel with the high-pressure output of the intensifier – added to smooth the pressure spikes (pressure variations from water compression can be reduced to ± 2.5%) that occur at the reversal of the reciprocating stroke of the intensifier.

28. What is the material used for the nozzle in WJM?

Material used most often for the nozzle orifice is synthetic sapphire because it is easily machinable and is resistant to wear. Recently, sapphire orifices have been replaced by diamond orifices whose life is ten times more. However, the cost of a diamond orifice is seven to ten times that of sapphire orifice

PART-B

1. Describe the principle and working of a USM with a neat sketch. List the advantages, limitations and applications of USM
2. Sketch and describe any two types of tool feed systems used in USM
3. Explain the factors, which influence the metal removal rate in USM. Compare USM with traditional abrasive machining.
4. Explain the principle and equipment used for AJM with the help of neat sketch .Mention the advantages, limitations and applications of AJM
5. Describe the effects of the following parameters on working accuracy and rate of metal removal in AJM: Grain size; Jet velocity; Standoff distance.
6. What is the principle of WJM? Describe the working of a WJM system with a neat sketch.
7. Explain the process control features of WJM. Mention the applications, advantages and limitations of WJM.

Unit – 3

Two Marks

1. What is the principle of Chemical Machining (CHM)?

Chemical attacks metals and etch them by removing small amounts of material from the surface using reagents or etchants

2. What are the processing steps in CHM? I. Preparing: precleaning
II. Masking : application of chemically resistant material (if selective etching is desired)
III. Etch: dip or spray exposure to the etchant
IV. Remove Mask: strip remaining mask and clean
V. Finish: inspection and post processing

3. What is etch factor?
Ratio of undercut to depth of cut

4. What are the two major processes in CHM?

- Two major CHM processes are:

I. Chemical milling - eroding material to produce blind details – pockets, channels etc.,
II. Chemical blanking – for producing details that penetrate the material entirely (holes, slots, etc.)

5. What is the purpose of etchant used in CHM? Give some examples.

- Purpose: to dissolve a metal by turning it into a metallic salt, which then goes into solution
- Many chemical are available as etchants:FeCl**3,** Chromic acid, FeNO**3**, HF, HNO**3**

6. What are the criteria used for selection of etchant?

- Required surface finish
- Removal rate
- Material type
- Etch depth
- Type of resist
- Cost

7. What is the purpose of maskant and how is it classified?

Maskants (chemically resistant coatings) are used to cover the surfaces which are not to be machined – does not allow the etchant to react reach and react with work piece to dissolve it.

8. Based on the techniques of applying maskants, classify them

- Cut and peel - Involve the use of relatively thick material which is scribed and removed to create a selective exposure to the etchant - Neoprene, butyl or vinyl-based material is used as maskants
- Screen printing - A fine mesh silk or stainless steel screen, which has areas blocked-off to allow selective passage of the maskant is used

- Photoresist masks – materials that produce etchant resistant images by means of photographic techniques.

9. How are maskants selected?

Selection of proper maskant for a particular application is accomplished by evaluation of the job with respect to six factors – chemical resistance, part configuration, quantity of parts, cost, ease of removal and required resolution

10. What are the applications for CHM and photochemical machining (PCM)?

CHM is used extensively to etch preformed aerospace parts to obtain maximum strength to weight ratios:

- Integrally stiffened Titanium engine ducts
- Spray etching a rotating tube for cruise missile launch tubes
- Thinning and sizing of a delta booster tank bulkhead
- Chemical sizing of engine cowl inlet duct skins
- Undercut on clad aluminium

11. What are the advantages of CHM and PCM?

- Metal removal is completely stress free
- Complex shapes and deeply recessed areas can be uniformly chemically milled
- Extremely thin sections can be chemically milled
- Metal hardness or brittleness is not a factor

12. What are the limitations of CHM & PCM?

- Fillet radius is approximately equal to depth of cut
- Extremely deep cuts are usually not cost effective
- A homogenous metal structure is normally required for good results
- Suitable photographic facilities are not always available

13. Please identify the principle of ECM. How does it differ from electroplating?

Principle of ECM - electrolysis. When a D.C potential is applied across two electrodes separated by a small gap and an electrolyte is pumped through the small gap, the constituents of the anode work piece material goes into the solution and not plate on the cathode tool. Electroplating is the reverse of ECM where the cathode is plated by the depleted metal from the anode.

14. What is Faraday's first law?

The amount of chemical changes produced by an electric current (or the amount of substance deposited or dissolved) is proportional to the quantity of electricity passed.

15. What is Faraday's second law?

The amount of different substances deposited or dissolved by the same quantity of electricity are proportional to their chemical equivalent weights.

16. Explain the parameters controlling the MRR in ECM. (Ref. P.N.Rao and Benedict)

MRR in ECM is primarily controlled by current density. When all other variables are held constant, the tool penetration rate is directly proportional to the current density. Current density is not only controlled by the amount of current but also by the size of the gap between the tool and the workpiece.

- Feed rate: a high feed rate results in a higher MRR. It also decreases the equilibrium machining gap resulting in improvement of the surface finish and tolerance control
- The velocity and the electrolyte flow through the gap is also an important parameter affecting the surface finish and removal rate

17. What are the various process parameters of ECM?

The process parameters that have a control on the performance of the ECM process is: Feed rate, current density, voltage, electrolyte concentration (low concentration of the electrolyte decreases the machining gap and results in a better surface finish and finer tolerance control) and electrolyte temperature (low temperature of the electrolyte is conducive to a better surface finish and tolerances), velocity and flow of electrolyte.

18. What are the various process characteristics of the ECM?

- Material Removal Rate – the MRRs with ECM are sufficiently large and comparable with that of the conventional methods. MRR of 16m^3/min for 10,000 A is generally obtained in ECM

- Surface finish – under certain conditions, ECM can produce surface finishes of the order of 0.4μm
- Accuracy – under ideal conditions and with properly designed tooling, ECM is capable of holding tolerance of the order of ± 0.02mm and less.
- Economy

19. What are the various tool materials that can be used effectively with ECM?

Generally aluminium, copper, brass, titanium, cupro-nickel and stainless steel are used as tool materials.

20. What factors should be considered in selecting the tool materials in ECM?

- High thermal and electrical conductivity
- Good stiffness- Rigidity of the tool construction and material is important because the high pressure can cause deflection of the tool
- Easy machinability- particularly important if complex shaped tools are required
- High corrosion resistance- to protect itself from the highly corrosive electrolyte solution

21. What are the different types ECM operations?

- Electro Chemical Milling (ECM)
- Electro Chemical Grinding (ECG)
- Electro Chemical Honing (ECH)
- Electro Chemical Deburing (ECD)
- Electro chemical turning (ECT)
- Electro chemical trepanning (ECT_r) etc.,

22. Enumerate some typical examples where ECM process can be effectively adopted.

- Deep hole drilling having L/D>20
- Contouring operations in the die blocks
- Through cutting and through cavities

23. What are the different applications of ECM?

- Aerospace industries: machining gas turbine blades, airframe component fabrication, honey-comb aircraft panels, jet engine blade airfoils
- Manufacture of general machine parts: thin wall mechanical slotting, difficult to machine hollow shafts, chain pinions, internal profile of internal cams, driving joints, pump glands and impellers, connecting rod, hydraulic spools, gear wheels
- Facing and turning complex 3D surfaces
- Cutting off

24. What are the advantages of the ECM process?

- Long tool life
- Machines complicated shapes in single pass
- Machines any material hardness – independent of physical and mechanical properties
- No burrs
- No stress
- Good surface finish
- Good accuracy

25. What are the limitations of the ECM process?

- Work must be electrically conductive
- High maintenance
- Can cause intergranular attack (IGA)
- High tooling and set-up costs

26. For which type of work, ECM is useful?

ECM is suitable for hard and difficult to machine materials and when complex shapes are required which are not machinable by conventional methods.

27. What is ECG? Identify its applications.

ECG is a process that combines the ECM with the mechanical grinding operation to remove material. It uses a grinding wheel with an electrically conductive abrasive bonding agent.

Applications:

- Single largest use for ECG is in the manufacturing and remanufacturing of turbine blades and vanes for aircraft turbine engines
- Grinding of tungsten carbide tool inserts
- Re-profiling worn locomotive traction motor gears
- Burr-free sharpening of hypodermic needles
- Machining of fragile or very hard and tough material – honey comb, thin walled tubes and skins
- High MRR's when grinding hard, tough, stringy, work-hardenable or heat sensitive materials

28. Explain the difference between the ECG and conventional grinding?

In ECG, there is a grinding wheel similar to a conventional grinding wheel except that the bonding material is electrically conductive.

Conventional grinding produces components with good surface finish and dimensional tolerances but such components are also associated with burrs, comparatively large heat affected zone (HAZ), and thermal residual stresses. These defects are not found in electrochemically ground workpieces.

29. What are the advantages of ECG over conventional grinding?

- Higher MRR
- Reduce cost of grinding (higher cost of equipment compensated by higher MRR, reduced consumption of expensive diamond wheels)
- Reduced heating of workpiece resulting in less thermal damage
- Absence of burrs on the finished surface
- Improved surface finish with no grinding scratches
- Reduced pressure of work against the wheel and so delicate parts can be manufactured without distortion

30. Identify any two advantages and limitations of electrochemical grinding (ECG)

Advantages

- No thermal damage to workpiece
- Elimination of grinding burn
- Absence of work hardening
- Long-lasting wheels – less truing
- Higher MRR;
- Single pass grinding - reduced cost of grinding;
- Absence of burrs on the finished surface;
- Improved surface finish with no grinding scratches;
- Reduced pressure of work against the wheel – no distortion;
- In ECG, the ECM action is efficient

Limitations

- High capital cost / Higher cost of grinding wheel;
- Corrosive environment
- High preventive maintenance cost
- Tolerance achieved are low;
- Difficult to optimize due to the complexity of the process;
- Non-conductive materials cannot be machined
- Not economical for soft materials – noncompetitive removal rates compared to conventional methods for readily machinable metals
- Requires disposal and filtering of electrolytes

31. What is ECH? Identify its applications.

ECH is a process in which the ***metal removal capabilities of ECM are combined with the accuracy capabilities of honing***. The process consists of a rotating and reciprocating tool inside a cylindrical component.

Applications: the process is easily adaptable to cylindrical parts for trueing the inside surfaces.

32. What is ECD? Identify its applications.

ECD is a process for the removal of metal burrs by anodic dissolution, the same principle as ECM.

Applications:

- Generally employed for far away located as well as inaccessible places where other deburring processes are not effective.
- ECD process has been successfully applied in many different industries ranging from consumer appliances and automotive to biomedical and aerospace products
- The automotive industry, a heavy user of ECD, employs this process for deburring and radiusing the cross-holes in crankshafts.
- Not only is ECD applicable to the high-volume environment of the automotive industry, but it is also applicable to the automated factory.

33. How does ECD differ from ECM?

ECD is a special version of ECM used exclusively to deburr or radius workpieces. It differs from ECM in that the electrolyte pressure, electrolyte flow, and current are all relatively low. Another major difference is that the cathode (tool) is usually held stationary in ECD.

34. ECD is same as ECM except much simple to use. Justify the statement.

ECD is same as ECM except much simple to use because, there is no feed mechanism needed for the ECD tool (the tool is held stationary). Moreover in ECD, the electrolyte pressure, electrolyte flow, and current are all relatively low.

35. What are the functions served by the electrolyte in the ECM process?

- Medium for current to flow
- Takes away heat generated
- Removes reaction products

PART-B

1. Explain the principle of ECM with a neat sketch. Mention the advantages, disadvantages, limitations and applications of ECM.
2. Briefly explain the various process parameters that affect the material removal rate and surface quality in ECM
3. What factors should be considered in selecting the tool materials in ECM? What are the materials commonly used for making a tool for use in this method? Is there any limitation on the type of material that can be machined by ECM?
4. With a help of a neat illustration, explain the process of ECG & ECH.
5. Explain the principle and working of CHM. Mention any four advantages, limitations and applications of CHM.
6. Discuss the criteria's that are applied in the selection of etchant and maskants
7. What are the different techniques adopted for applying maskants. Briefly elaborate them.

Unit – 4
Two Marks

1. What is the principle of EDM?

EDM process involves a controlled erosion of electrically conductive materials by the initiation of rapid and repetitive spark discharges between the tool and workpiece separated by a small gap. The controlled pulsing of the direct current between the tool and the workpiece produces the spark discharge. Heat transfer from the spark to both the tool and workpiece makes the latter to melt and partially vaporise and partially ionise the metal in a thin surface layer.

2. What causes the material to be removed from the workpiece surface? (Or) How does the dielectric assist in removing the material from the workpiece?

Due to the inertia of the surrounding fluid, the pressure within the spark becomes quite large and may possibly assist in "blasting" the molten material from the surface leaving a fairly flat and shallow crater.

3. What are the principle components of EDM process?

Power supply, Dielectric system, electrodes: workpiece and tool and servo system (tool feed)

4. What is the use of dielectric in EDM process?

- spark conductor that must ionize under an applied voltage
- deionize the spark gap after the discharge has occurred
- effective cooling medium (coolant)
- carry the swarf particles away from the working gap (flushing medium)

5. What the dielectric fluids commonly used in EDM?

- Petrolium based hydrocarbon fluids.
- Parafin, white sprite, transformer oil.
- Kerosine, mineral oil.
- Ethylene glycol and water miscible compounds.

6. List the desirable characteristics of a dielectric.

The following are the desirable characteristics of a dielectric:

- It should have sufficient and stable dielectric strength to serve as an insulation between the tool and work till the breakdown voltage is reached
- It should deionise rapidly after the spark discharge has taken place
- It should have low viscosity and good wetting capacity to provide an effective cooling mechanism and remove the swarf particles from the machining gap
- It should be chemically neutral so as not to attack the electrode, workpiece, table or the tank.
- It should not emit any toxic vapours or have any unpleasant odour.
- It should have high flash point so as to avoid any fire hazards.
- It should maintain its properties over a wide range of temperature, contamination by debris and products of decomposition.
- It should be economical and easily available.

7. What is tool wear in the EDM process?

Partial removal of the tool material form the tool surface while machining the workpiece due to the discharge spark produced between the tool and the workpiece.

8. How does tool wear occur in the EDM?

Due to the sparking action, the intense heat generated near the zone melts and evaporates the materials in the sparking zone. Since the ***tool is also within this zone***, it also gets eroded.

9. How to minimise tool wear in EDM?

Tool wear can be minimized by using a tool material that has a high melting point and high thermal conductivity. Also by properly configuring the tool design, tool wear can be minimized.

10. Please identify the characteristics of an electrode material in order to serve as a good tool.

- It should be a good conductor of electricity and heat
- It should be easily machinable to any shape at a reasonable cost
- It should produce efficient material removal rates from the workpieces
- It should resist the deformation during the erosion process
- It should exhibit low electrode (tool) wear rates
- It should be easily available in a variety of shapes

11. Name some of the tool material used in EDM?

- Copper, brass, alloys of Zinc &tin.
- Hardend plain carbon steel
- Copper tungsten, silver tungsten, tungsten
- Copper graphite and graphite.

12. Why is graphite the most preferred electrode material in EDM?

Graphite has very high melting point (3727°C). It does not melt rather vaporizes. At the same time, the tool wear is minimum.

13. How does the melting temperature of work material affect the MRR in EDM?
Work materials having higher melting temperature have lower MRR's.

14. What is the effect of capacitance in EDM?

Increasing the capacitance causes the discharge to increase and increase both the peak current and discharge time.

15. Define wear ratio
It is the ratio of volume of work removed to the volume of tool removed.

16. Define over cut

It is the distance by which the machined hole in the work piece exceeds the electrode size and is determined by both the initiating voltage and the discharge energy.

17. What is recast layer?

If molten material from the workpiece is not flushed out quickly, it will resolidify and harden (as a martensite) due to cooling effect of the dieletric, and gets adhered to the machined surface. This thin layer (about 2.5 to 50μm) is known as re-cast layer.

18. Name the best electrode material for finish operations on a small die made of WC by the EDM process.

Best electrode material for finish machining a small die made of WC – *steel*. Steel is used because it can match the parting planes of the moulds in which half the mould is used as the electrode and the other half is used as the workpiece.

19. Explain why tool shape in the EDM process should be complementary to the final form?

Since the ***arc is always struck at a point between the workpiece that is closest from the tool*** (electrode), the complementary tool surface will be reproduced in the workpiece.

20. What are the factors upon which the material removal rate and surface roughness depends?

- Increase in **current or spark voltage** increases MRR and produces higher surface roughness
- Increase in **spark frequency** results in improved surface finish but the MRR can be maintained
- Low inter electrode gap (IEG) results in lower MRR, higher surface finish and better accuracy

21. What are the design factors to be considered while selecting the machine tool?

- Number of parts to be produced.
- Accuracy.
- Size of work piece.
- Size of electrode.
- Depth of cavity.

22. Why is a servo-controlled system required in EDM?

EDM requires that a constant arc gap be maintained between the electrode and the work piece to obtain maximum machining efficiency. Therefore EDM tool incorporates some form of servo control.

23. What are the various applications of EDM?

- Mould –making industry –manufacture moulds for plastics
- Tool and die industry- manufacture extruding, heading, drawing, forging and die lasting dies.
- Aerospace and electronic industry – to make prototypes and production parts- made of difficult to machine material
- Small or odd – shaped holes
- Miniature parts and parts made from thin or fragile materials (delicate)

24. What is meant by Wire cut EDM?

The principle and working of an WEDM is similar to the EDM but instead of using a solid electrode, a wire (about 0.05-0.30mm diameter) is used as an electrode in EDM.

25. What are salient features of WEDM?

WEDM uses a small diameter wire as tool electrode, which produces a very narrow kerf in the work. Because of this reason, very sharp corners can be easily produced.

26. Please identify various applications of Wire cut EDM. Wire cut EDM is used for the manufacture of:

- Dies
- Press tools
- Electrodes

27. What are the different types of the electrical circuits that are used for electro spark machining?

- R.C. Circuits
- Rotary impulse generator
- Pulse controlled circuits
- Hybrid circuits

28. What is an arc gap?

Optimum distance between the tool and the workpiece so that spark can run and cause useful erosion.

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29. How is the arc gap controlled in EDM?

Servo mechanism is used to control the arc gap –average voltage is measured and as long as it is within a certain limit, no correction signal is fed to the feed drive.

30. What are the limitations of EDM process?

- Low material removal rate
- Only electrically conductive materials can be machined
- Tool electrode wear is very high
- More time in the fabrication of the electrodes.
- High cost involved.

PART-B

1. With the help of a neat sketch, explain the working of a spark erosion machine.
2. What are the desirable properties of a dielectric fluid? Gives some examples for dielectric fluids. Explain the functions of dielectric fluid.
3. What are the important process parameters that control the material removal rate in EDM? Explain any four factors
4. Explain the process of wire cut EDM and list any two of its advantages, limitations and applications.
5. Explain the process of Electrical discharge grinding and list any two of its advantages, limitations and applications.
6. Explain the process of Electrical discharge wire cutting processes and list any two of its advantages, limitations and applications.
7. Explain the different types of power generator circuits in EDM.

Unit – 5

1. What is the principle of EBM?

A stream of high-speed electrons impinges on the work surface whereby the kinetic energy, transferred to the work material, produces intense heating. Depending on the intensity of the heat thus generated, the material can melt or vaporize.

2. What is the principle of LBM?

Under proper conditions light energy of a particular frequency is used to stimulate the electrons in an atom to emit additional light (photon- unit of the light) with exactly the same characteristics of the original light source.

3. What is the principle of PAM?

Plasma is defined as a superheated, electrically ionized gas. The cutting action takes place by directing the high-velocity plasma stream at the work, thus melting it and blowing the molten metal through the kerf.

4. Identify the essential constituents of the electron gun?

Answer: Function is to generate, shape and deflect the electron beam to drill or machine the workpiece. The essential constituents of the electron gun are:

- Cathode- source of the electrons
- Bias Grid- to control the no. of electrons and acts as a switch for generating pulses
- Anode- to accelerate the electrons

Magnetic coil that functions as a magnetic lens, repels and shapes the electron beam into a converging beam

5. Compare EBM and LBM.

- LBM does not require vacuum for operation
- Power density (output in watts which can be concentrated upon an area, usually expressed in units of W/mm^2) are greater for laser than EBM
- The LBM cannot be deflected electrically, so that the movement of the beam with respect to the workpiece must be carried out mechanically. Therefore, the LBM cannot be controlled as accurately and machining tolerances are less, being in the order of 0.01mm.

6. What is LASER?

LASER stands for Light Amplification by Stimulated Emission of Radiation.

7. What are the applications of LBM?

- LBM is again a micromachining method which can be used for a wide range of metal processing applications such as metal removal – drilling, trepanning; metal shaping – cutting, scribing and controlled fracturing
- Most of the LBM drilling applications are in small hole drilling such as fuel filters, carburetor nozzles, surgical and hypodermic needles, hole for lock-nut safety wires, jet engine blade cooling holes, diamond drawing dies, holes in rubber baby bottle nipples, relief holes in pressure plugs, holes in nylon buttons
- Laser beam can be used for making or engraving so as to produce controlled surface pattern on a workpiece – company logos, part number, bar codes or serial number can be made. Metal, glass and paper can also be marked in this way.
- For vaporizing foreign material clogged in electron microscope apertures.

PART-B

1. Describe, with the help of neat sketch, the principle and working of an EBM machine
2. Describe, with the help of a sketch, the constructional features of a electron gun used for generating an electron beam in EBM
3. Explain the different types of gun used in EBM.
4. Make a comparison between LBM and EBM processes on the basis of their working, control of beam, applications and limitations
5. Describe, with the help of a neat sketch, the working of a solid state laser beam machine or Explain the process of LBM with a neat sketch or explain any one method of producing laser.
6. Explain the principle of PAM. Compare PAM with gas cutting. Discuss about PAM process parameters
7. Explain the process capabilities of EBM and PAM
8. Explain the Magnetic abrasive finishing and abrasive flow finishing processes.

DEPARTMENT OF MECHANICAL ENGINEERING

SUB: ME6004 UNCONVENTIONAL MACHINING PROCESS

QUESTION BANK

UNIT- I (Introduction)

PART – B (16 MARKS)

4. Explain the factors that should be considered during the selection of an appropriate unconventional machining process for a given job.

5. Compare and contrast the various unconventional machining process on the basis of type of energy employed, material removal rate, transfer media and economical aspects.

UNIT II (MECHANICAL ENERGY BASED PROCESSES)

PART - B (16 MARKS)

1. (i) Explain the principle of AJM. Mention some of the specific applications. (6)
   (ii) Discuss in detail about the AJM process variables that influence the rate of material removal and accuracy in the machining. (10)
2. (i) Explain the method of AJM with help of schematic diagram.(10)
   (ii) Mention the advantages and limitations of AJM.(6)
3. Explain the process parameters in WJM processs.(16)
4. With neat sketch explain the process of AJM .List its application and limitations.(16)
5. (i) Explain the process parameters that influence WJM.List the applications and limitations of WJM(10)
   (ii) Briefly discuss the application and limitation of WJM.(6)
6. Explain the USM machine setup an discuss various feed mechanisms.(16)
7. (i) Discuss the influence process parameters and applications of USM (10) (ii) Give a note o the various types of transducers.(6)

UNIT- III (ELECTRICAL ENERGY BASED PROCESSES)

PART - B (16 MARKS)

1. Explain the process of electrical discharge machining, its process parameters and applications. (16)
2. Describe the wire cut EDM equipment, its working, applications and advantages

3. (i) With the help of neat sketch, Describe the EDM process.(12)
   (ii)Explain briefly advantages of wire EDM process.(4)
4. (i) Explain the classification and characteristics of various spark erosion generators. (8)
   (ii) With help of neat sketch describe the mechanism of material removal in EDM. (8)
5. (i) Explain the working principle, elements and characteristics of wire EDM. (10)
   (ii) Explain how the stratified wire works. Also discuss about the recent developments in wire EDM. (6)

UNIT- IV (CHEMICAL AND ELECTRO - CHEMICAL ENERGY BASED PROCESSES)

PART- B (16 MARKS)

1. (i) Describe the chemistry involved in ECM process. (8)
   (ii) Briefly discuss about the effect of high temperature and pressure of electrolyte on the ECM process. (4)
   (iii) Discuss about the economics of ECM. (4)
2. (i) Describe the working principle and elements of chemical machining. What are the factors on which the selection of a resist for use in chemical machining? (10)
   (ii) What are the specific advantages of using chemical machining over electro chemical machining? Give some of the practical applications of chemical machining process. (6)
3. (i) Explain the principle of ECG with sketch. (8)
   (ii) List out the advantage of EGC over conventional grinding.(4)
   (iii) Mention the product applcation of ECG.(4)
4. Explain in detail the ECM process with neat sketch and also mention the advantages and application. (16)
5. (i) Describe the process of electrochemical machining. (8)
   (ii) Discuss about the electrochecmical honing and electrochecmical grinding. (8)

UNIT- V (THERMAL ENERGY BASED PROCESSES)

PART-B (16 MARKS)

1. Explain the process of LBM and PAM with neat sketches.
   (i) Discuss the process parameters of EBM and their influence on machining quality.(8)
   (ii) Explain the process capabilities of EBM and PAM. (8)
2. (i) Explain the principle of LBM with neat sketch. (10)
   (ii) List out the advantage and limitation of LBM process. (6)
3. (i) Explain the principle of PAM with sketch (10)
   (ii) List out the advantage and limitation of PAM process.(6)
4. (i) Mention the application of EBM.(4)
   (ii) What is EBM? Sketch its set up an indicate its main parts and explain the principle of operation. (12)
5. (i) Explain the principles and elements of EBM, also how the work table is protected from getting damaged by electron beam. (8)
   (ii) Discuss how the process variables influence MRR, HAZ and pattern generation. (8)