ME-223: Manufacturing Processes II

Tutorial - II

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5) What is non-conventional machining process? State advantage & disadvantage?-

A) Non conventional machining process are also known as non-traditional machining process. It is a special process where there is no direct contact b/w tool & workpiece, instead, we are using a form of energy such as thermal, electrical & chemical & a combination of these energies rather than cutting tools. They can be called as supplements for ~~machining process~~ conventional processes.

Advantages :-

i) Suitable for hard & brittle materials.
ii) Minimal heat-affected zones.
iii) Minimal tool wear & longer tool life.
iv) Precise maching of intricate shapes.
v) No burrs or mechanical stresses on workpiece.
vi) Capable of Micro machining & small-hole drilling.

Disadvantage :-

i) Specialized equipment & tooling required for non-conventional machining processes can be expensive.
ii) Material removal rate can be slower in some non-conventional processes.

iii) Setting up & operating the process may require specialized knowledge & expertise.

iv) Maching deep cavities might be challenging.

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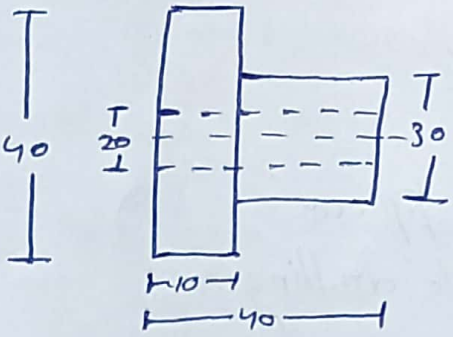
10) What is numerical control (NC) & Computer Numeric control (CNC) System ? Write machining program using G & M codes?

Ans) Numerical control refers to automation of machine tools using set of instructions that directs the movment & operations of machine. They are typically hardwired, meaning they do not have flexibility of modifying the program without changing the punched tape card.

Whereas, in CNC, it is an advanced version of NC in which computers are integrated with machine. Program is stored in computer's memory & can be modified. They allow real-time feedback & error correction, & flexibility. Program can be created, edited & simulated on computer enhancing complex operations.



G54 G21 G80 G40 G97
T0303 M06
M03 S1000
G00 X0.0 Z5.0 M08
Z1.0
G01 Z-3.5 F0.08
G00 Z5.0
G53 X0.0 Z-210.0
M09
M05
M01

1) Explain optimization of maching in terms of cost & production rate?

Ans) Economics of machining has two important parameters :-

i) Minimum cost per part.

ii) Maximum production rate

C_p = Cost per w/p
C_m = maching cost
C_s = Setting cost
C_l = loading cost
C_t = tooling cost

Total cost perw w/p has 4 items,

$$C_p = C_m + C_s + C_l + C_t$$

Maching cost given by,

$$C_m = T_m (L_m + B_m)$$

T_m = machining time
L_m = Labour cost /hr
B_m = Burden rate

Loading, unloading cost given by,

$$C_l = T_l (L_m + B_m)$$

T_t = Time involved in loading

Tooling Cost is expressed as,

$$C_t = \frac{1}{N_t}\left[T_c(L_m+B_m)+D_i\right] + \frac{1}{N_y}\left[T_i(L_m+B_m)\right]$$

N_i = no. of parts machined per insert
N_y = no. of parts machined per insert face
T_c = time req. to change insert
T_i = time to fix index
D_i = depreciation of index
T_m = machining time
L_m = Labor cost
B_m = burden rate
T_i = time involved
L = length, f = feed rate
N = rpm, D = dia.
V = cutting velocity

Time req. to produce one part

$$T_p = T_i + T_m + \frac{T_c}{N_i} + \frac{T_i}{N_y}$$

$$T_m = \frac{L}{fN} = \frac{\pi L D}{fV}$$

∴ from taylors tool life Eqn

$$VT^n = C \quad \text{or} \quad T = \left(\frac{C}{V}\right)^{1/n}$$

∴ Optimizing machining process in terms of minimum cost per part

$$V_o = \frac{C(L_m+B_m)^n}{\left(\frac{1}{n}-1\right)^n\left\{\frac{1}{m}\left[T_c(L_m+B_m)+D_i\right]+T_i(L_m+B_m)\right\}}$$

$$T_o = \left[\left(\frac{1}{n}\right)-1\right]^n \frac{\frac{1}{m}\left[T_c(L_m+B_m)+D_i\right]+T_i(L_m+B_m)}{L_m+B_m}$$

Optimization of machining process in terms of max. production rate

$$\frac{\partial T_p}{\partial V} = 0$$

optimum cutting speed V_o

$$V_o = \frac{C}{\left[\left(\frac{1}{n} - 1\right)\left(\frac{T_c}{m} + T_i\right)\right]^n}$$

Optimum tool life T_o

$$T_o = \left(\frac{1}{n} - 1\right)\left(\frac{T_c}{m} + T_i\right)$$

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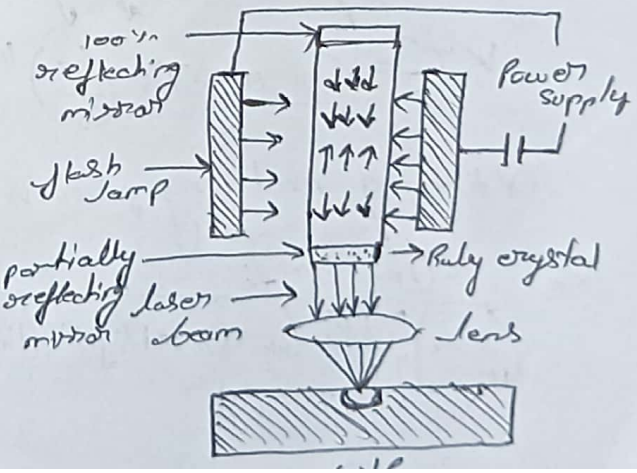
7) What is laser beam machining (LBM)? Explain in detail LBM process with diagram & applications?

Ans) LBM is a non-conventional machining process that utilizes concentrated energy of laser beam to remove material from workpiece. This process is particularly used for cutting, drilling works, that are difficult to machine using traditional methods.

LBM is based on the principal of converting electrical energy into a highly focused beam of laser. This beam strikes the surface of workpiece, this process produces intense heat that melts & vaporizes material in localized area, giving precise machining



Process :-

→ A high voltage is applied across flash tube. A capacitor is used to operate flash tube at pulse mode.

→ Flash tube then emits light photons which is absorbed by ruby crystal. This will excite e- to high energy level & population inversion (excited e- > ground e-). Excited e- jumps back to ground state & emits light photon

→ The spontaneously emitted photon simulates the excited e- which returns to ground state by emitting 2 photons.

→ The 100% reflecting mirror bounces back all photons into crystal. Partially reflecting mirror reflects some of the photon back to crystal, some escape out & form a highly conc. laser beam.

→ A lens then focuses beam to desired location & then the beam heats, melts & vaporizes w/p material.

Applications :-

- Drilling microsized holes in difficult to machine materials
- Medical industry, for several kind of surgeries.
- Spot welding & cladding.
- Cutting complex profile on both conductive & non-conductive & brittle materials.

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a) Explain Interchangable & Selective assembly in manufacturing?

Ans) → Interchangable Assembly :-

- Interchangable part is the one which can be substituted for similar part manufactured to same drawing.
- It ensures increased output with reduced production costs, but international standards must be followed for manufacturing.
- Randomly selected mating parts should assemble correctly without any classification or alteration for mating purposes.

- Eg:- M6 bolt will fit into any randomly selected M6 nut.

Selective Assembly :-

- Part manufactured to rather wide tolerances fit & func. The components produced by machine are measured & sorted into several groups by dimensions, prior to assembly.
- Both conditions of high quality & low cost can be served by this method.
- An automatic gauge can be adopted for segregation of parts in different groups.
- Eg:- Aerospace for precision fits in critical components.

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8) What are jigs & fixtures & how they are fabricated? Explain principle of location & clamping with suitable ~~Explain~~ example?

Ans) Jigs & fixtures are essential tools used in manufacturing to hold, support & locate workpieces during machining, assembly, inspection processes. They ensure precision, accuracy & repeatability while enhancing productivity.

→ A well designed fixture needs to restrict all possible DOFs to keep w/p locked in position but avoid over constraining which could result in poor part quality & more risk. Jigs & fixtures should have human-centric designs such that,
- can be operated with one hand
- no human assistance required
- should use fewest steps.

→ They can be manufactured using CNC machining & 3D printing & also additive manufacturing which is cheaper & faster

→ They can be made of metal, plastic, FDM, DLS, SLA & SLS

Principle of location :-

It ensures that w/p is held in correct position relative to cutting tool so it can prevent movement during machining.

→ A min. 6 points of location is required (3-2-1 principle)

* point on primary

Eg :- for rectangular block :-

a) 3 point on primary plane to restrict movement of Z-axis
b) 2 point on secondary plane to restrict movement of y-axis
c) 1 point on tertiary plane to restrict on X-axis

Principle of clamping :-

It involves securing w/p in located position during machining to resist cutting force without distorting w/p.

Clamps/Method :-

Mechanical clamps :- Screws, toggle, levers
Hydraulic " :- faster operations
Magnetic :- Ferromagnetic materials

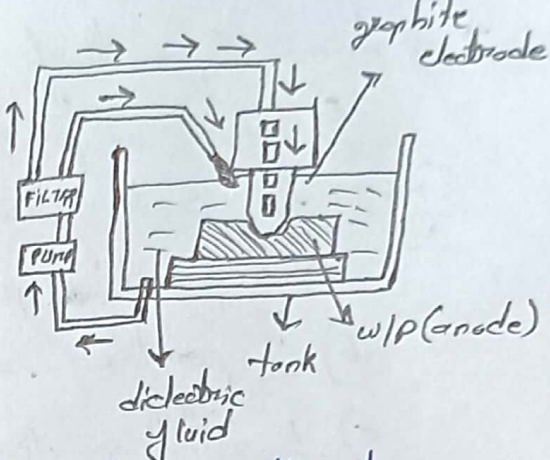
Eg :- Again for Rect. block :-

→ clamping should not affect accuracy of location.
→ resist machining forces.
→ Allow quick loading & unloading.

Q-6) What is electro discharge machining (EDM)? Explain in detail with diagram?

Ans) EDM is non-conventional machining process that uses electrical discharges to remove material from workpiece. Useful for machining hard & electrically conductive materials that are difficult to machine traditionally.

EDM works on the principle of thermal erosion. Series of controlled electric discharges occur b/w tool electrode & workpiece submerged in dielectric fluid. Sparks generate heat, causing material on w/p surface to melt & vaporize.



Process :-

→ w/p & tool electrode are submerged in dielectric fluid

→ DC power supply generates high frequency electric discharge b/w tool & w/p

→ Sparks produce localized heat up to (10,000°C), melting small volume of material from workpiece. The molten material is quickly cooled by dielectric fluid, solidifies & flushed away as debris.

→ Servo mechanism advances tool electrode toward the w/p to maintain constant spark gap

→ tool electrode shape is reproduced as cavity on w/p.

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4) Explain finishing process with advantages, disadvantages & applications?

Ans) i) Grinding :- In grinding, a rotating abrasive wheel is used to remove material from the surface of w/p.

→ Advantages :- i) high dimensional accuracy
ii) Ability to machine hard material
iii) produce smooth surface.

→ Disadvantage :- i) heat generation
ii) high energy consumption

→ Application :- i) Sharpening tools
ii) finishing hardened components.

2) Honing :- honing is a low grinding process mostly for finishing round holes using bonded abrasive stone sticks.

→ Advantages:- i) highly accurate process
ii) can be used for any material regardless of hardness
iii) Several holes can be honed simultaneously.

→ Disadvantage:- i) initial cost is high
ii) roughness of abrasive stone gets decreased easily.
iii) not effective on non-ferrous materials.

→ Application:- i) To finish bores of internal combustion engines
ii) finishing automobile crankshaft journals

3) Lapping:- In lapping, a fine abrasive slurry is applied b/w 2 surfaces one is lap tool, to produce extremely smooth & precise surfaces.

→ Advantages:- i) Removes very thin layers of material
ii) excellent flatness & surface finish

→ Disadvantage:- i) Very slow MRR
ii) Expensive due to precision requirements.

→ Application:- i) optical lenses
ii) precision gauges.

4) Polishing:- Uses soft abrasive material to smooth & shine a surface by removing scratches & oxidation.

→ Advantages:- i) enhances appearance & reduces surface roughness
ii) increases resistance to corrosion

→ Disadvantages:- i) Labor-intensive
ii) Limited cosmetic improvements for certain processes.

→ Applications :- i) Jewellery
ii) Automotive components.

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3) What are special purpose machines? Explain two of them with advan., disadv. & applic. ?

Ans) SPMs are customized machines designed to perform specific task or process that cannot be efficiently accomplished using standard machines. They are tailored to meet particular needs ensuring productivity.

SPMs are used in mass production environments where repetitive tasks need to be performed with minimal human intervention.

i) Automated Drilling Machines :- Designed for drilling multiple holes simultaneously on specific component tailored to product's geometry.

→ Advantages :- • high productivity due to simultaneous operation
• consistent accuracy & hole alignment

→ Disadvantage :- • high initial cost
• Less flexibility for changes in design.

→ Application :- • Drilling holes in PCB boards for electronics.
• manufacturing engine blocks.

ii) Automatic packaging machine :- Designed to perform packaging operations like filling, sealing, labelling & wrapping in automated sequence

→ Advantages :- • high speed & efficiency
• Consistent quality & precision

→ Disadvantages :- • high initial investement
• Limited to specific product sizes.

→ Applications :- • Pharmaceutical industry for tablet packaging
• food & beverage industries for bottling & labelling

2) What are production machines? Explain any 2 with adv, disadv & applications? (8)

Ans) Production machines are tools or equipment designed to manufacture products or components in large quantities. These machines play critical role in mass production & help industries meet high demand by automating repetitive procedures.

Different types are lathe, milling, drilling, press, CNC, grinding.

i) Lathe machines :- It is a versatile production machine used to perform various machining pp. by rotating w/p against stationary cutting tool.

→ Advantages :- i) performs multiple ops. like turning, facing etc.
ii) Can work on wide range of materials.

→ Disadvantages :- i) limited to rotationally symmetric parts.
ii) requires skilled operators

→ Applications :- i) Thread cutting for screws & bolts
ii) Manufacturing shaft, pulleys & bushings.

ii) Milling Machine :- Uses a rotating cutting tool to remove material from stationary w/p, producing flat / contoured surface.

→ Advantages :- i) performs multiple ops like drilling, contouring, etc.
ii) Machines complex shapes with high precision.

→ Disadvantages :- i) high initial cost
ii) Requires skilled operators

→ Applications :- i) fabricating molds, dies.
ii) producing gear slots & pockets.