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CAD

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Computer Aided Design / Drafting

Computer Aided Design is the use of Computer to help in the creation, modification or organisation of design.

Advantages of CAD

- ① Less time taken to produce design or drawing.
- ② with the help of tool it is very easy to use.
- ③ Accurate Dimensioning.
- ④ It is possible to make changes in design and its dimension.
- ⑤ No need of repetition as it can be used multiple times.
- ⑥ CAD can produce 3D-drawings so as to facilitates the work of actual Component.

Function of CAD

- ① Product Design and manufacturing.

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- ② Building, Construction, Architectural design, 3D Printing.

CAM

Computer Aided Manufacturing is the use of Software and hardware to automate a manufacturing process.

Advantages of CAM

- ① The time will be reduced.
 - ② Greater Accuracy and Consistency with each component.
 - ③ Greater Efficiency as Computer Control machine do not take break.
 - ④ Good Speed and quality.
 - ⑤ High Complex product can be made accurately.
 - ⑥ Support for any changes.
- Dis-Advantages
- ① High Initial set up Cost.

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- ② Maintenance will be high and Cost also.

- ③ High quality Software and Hardware are required.

- ④ Manufacturing is suitable for Mass production.

- ⑤ Highly Skilled operator are required to operate the machine.

NC Machine - Numerical Control Machine.

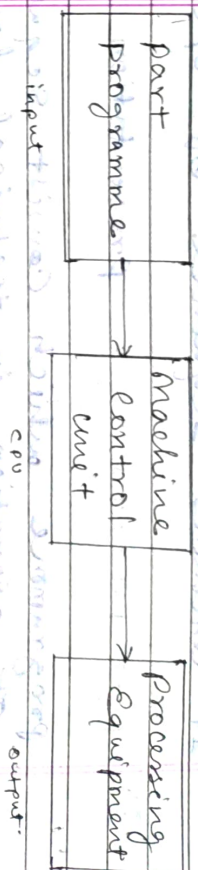
Numerical Control is the technique of giving an instruction to a machine in the form of codes, which consists numbers, alphabet, punctuation marks and symbol, Controlling a machine tool by means of prepared programme is known as Numerical Control Machine (NC).

Advantages

- ① High Metal Removing Rate.
- ② Reduce non-productive time.

- ③ Greater Manufacturing flexibility.
 - ④ Improve Quality Control.
 - ⑤ Quality of production can be controlled easily.
 - ⑥ Reduce Floor space or area required.
 - ⑦ Manufacturing data can be retained.
- Note For part programming punch Tape is to be used.
- Dis-Advantages
- ① Punch Tape is fragile in nature (easy to destroy.)
 - ② Punch Tape reader is not reliable.
 - ③ Speed Feed Depth of cut are not changeable during machining.
 - ④ Part programming either are tough to examine.
 - ⑤ Higher Maintenance Cost.
 - ⑥ High skilled programmer is required.

Component of NC Machine.



- ① Part programme / Programme of Instruction
It is generally a punch tape which include all the steps involved for machining.

- ② MCU: It reads the part programme and give Command to machine tool in Conventional NC machine. They consist of tape reader unit, buffer unit. and input channel for feedback.

- ③ Processing Equipment / Machine Tool:
It consist of motor and different tools for required machining.

NC procedure

- ① process planning: Making of route set is known as process planning

It includes Sequence of operation.

② Part programming :- presentation on

programme which consist sequence of operation in technical language in following 2 ways: (i) manual part programming (ii) computer assist part programming.

③ punch Tape preparation :- NC process

plane punch tape is prepared by skilled part programmer.

④ punch Tape verification :- The tape is being verified by two or more part programmer in order to find any error in the programme.

⑤ production :- The tape is feeded into a controller and machine tool is feeded with the raw material for production or machining of the component.

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CNC

Computer Numerical Control (CNC) - CNC machining is the manufacturing process in which pre-programmed computer software directs the movement of factory tools and machinery.

Functions of CNC

① Control Function - Control the axis.

② Feed Function

③ Spindle Function / Spindle speed Control

④ Tool Function - Select desired tool

⑤ Self Diagnostic Function - (Caution from failure)

⑥ Graphic Display Function - CRT and LCD Display are used.

Advantages of CNC Machine

① Rapid production of complex design.

CNC machine processes the ability to produce intricate

Design with remarkable accuracy in the shortest possible time.

② Quick Adjustment and Improvement:

Operator can easily make changes and improvement to the CNC programme reducing delay time and enhancing production efficiency.

③ Operator Skill Flexibility: Highly

skilled operator are not mandatory for operating CNC machine even semi-skilled operator can achieve accurate and precise result.

④ Consistent Quality: The part

manufactured by CNC machine exhibit consistent accuracy, eliminating variation in the final product.

⑤ Continuous operation: CNC machine

can be operated 24 hour a day enabling efficient and uninterrupted production schedule.

⑥ Accuracy and Precision: CNC

machine require fewer workers

to operate, resulting in reduced labour cost and increased productivity.

⑦ Labour Efficiency: CNC machine

require fewer workers to operate resulting in reduced labour cost and increased productivity.

⑧ Virtual prototyping: Modern design

software enables the designer to simulate their ideas, eliminating the need for physical prototypes and models, thereby saving time and resources.

Dis-Advantages of CNC Machine.

① High Initial Cost: One significant

drawback is their high initial investment compare to manually operated machines. The initial set up cost can be substantial making it challenging for some business to afford.

② Expensive parts: The component

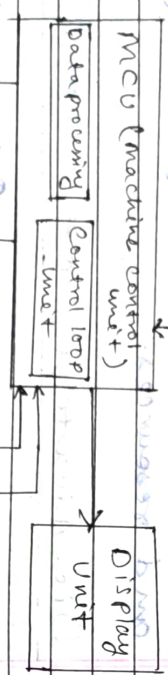
and parts used in CNC machine can be costly adding to the overall expense for repair and replacement.

③ High Maintenance Expenses - CNC machine often require specialized maintenance and cost of servicing and repair can be relatively high.

Component of CNC Machine

Input Devices

Part Programme



Motion data

Miscellaneous Function

velocity Feedback



① Input Devices: These devices are responsible for inputting the part programme in the CNC machine. These are commonly used input devices:

- ① punch tape ② magnetic tape reader
- ③ Computer

② Machine Control Unit: Machine control unit serving as the heart of CNC machine. The MCU performed all controlling action. It's various function included reading the coded instruction, decoding them, implementing, interpolation to generate axis motion command feeding this commands to amplifiers.

Circuit for driving the axis mechanism, receiving feedback signal of position and speed for each drive axis and implementing auxiliary control function such as coolant on/spindle on/off and tool changes.

③ Machine Tool: CNC machine tool slide table and spindle

to control the position and speed. The machine table is controlled in X and Y direction and Spindle is controlled in Z direction.

④ Driving System : The driving system consists of

amplifier circuit drive motors and ball lead screw. The MCV feeds the signal of each axis (that is position and speed) to the amplifier circuit, which then increase the control signals to activate the drive signal. The activated drive motors then turn rotate the ball lead screws to position the machine table.

⑤ Feedback System : This system incorporates transducers that act as sensor and measuring devices.

It continuously monitor the position and speed of cutting tool at any given moment. The MCV receives signal from this transducer and utilise the differences between reference and feedback signal to generate control signal for correcting position and speed errors.

⑥ Display Unit :

Monitor is used as a display unit to show CNC machine programmes, commands and other pertinent data.

DNC

Direct Numerical Control is defined as a system that integrates multiple machines by direct connection through a central computer.

The central computer is design to provide instruction on demand to each machine tool. The central computer also retrieves data from machine, therefore there is two way information exchanged between central computer and each of the machine tool.

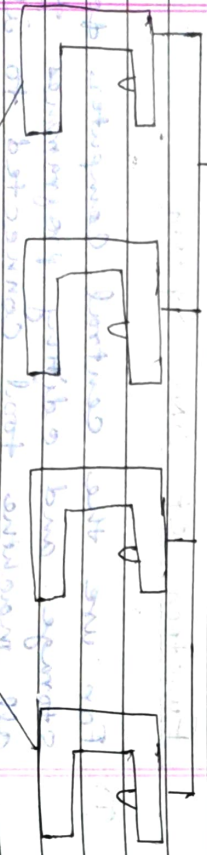
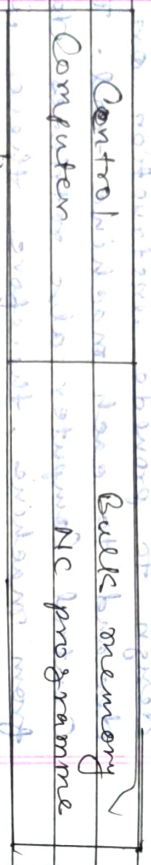
Function of DNC System

- ① For use the central computer for storage and editing programmes for all machine tool connected to it.
- ② To give stored programme to the connected machines on demand.
- ③ To combine CAD with CAM by having a common database.

④ To provide link between a Central Computer and various plant Computer. Connected through modem and network even though the plants may be placed several kilometre from each other.

⑤ To post process part programme written in higher languages.

Components of DNC Machine



Components of DNC Machine

① Central Computer ② Telecommunication line ③ Bulk memory ④ Machine Tool.

① Central Computer: The central computer calls the part programme instructions from bulk storage and send them to each of the machine tool whenever required. It also receives data back from machines which are called feedback data. There is way information transfer - variation occurs almost immediately.

② Bulk Memory: Group of part programme instruction received from a central computer is stored in buffer in known as bulk memory. These stored instruction are given to each of the machine tool when required. Feedback data from machine tool is also stored in ~~buffer~~ buffer. While sending it to the central computer.

③ Telecommunication line: These are used in DNC systems. For transmitting information from work station to another station. Transmission of data may be from central

Computer to the machine tool and vice versa.

④ Machine Tool: These are individual structure that requires the control the function of themselves.

Advantages of DNC machine.

- ① Elimination of punch tape and punch tape reader
 - ② More than one machines are controlled by single system.
 - ③ Greater computational capability and flexibility
 - ④ Convenient editing and diagnostic feature.
 - ⑤ Convenient storage of NC part programs in computer files.
- Dis-Advantage of DNC M/C
- ① High Initial Cost

② High Maintenance cost.

③ Complex Implementation - Integrating multiple CNC machines into a network can be complex and may require specialized expertise.

④ Security Risk - Since data is transmitted over a network, there is a risk of unauthorized access, hacking or data corruption.

⑤ Dependency on Network & Central Computer - If the Central Computer or network fails, all connected machines may be affected, leading to downtime.

⑥ Limited Flexibility - If a specific machine needs to operate independently, it may require additional configurations or modifications.

⑦ Training Requirement - Operator and Engineers need to be trained to use the DNC system effectively, increasing initial learning time.

⑧ Compatibility Issues - Older CNC machines

may not support DNC integration, requiring costly upgrades or replacement.

Despite these disadvantages, DNC m/c's are widely used in modern manufacturing for their ability to streamline operations and enhance production efficiency.

* Difference Between CNC & DNC m/c's

CNC

DNC

① punch tape can also be used to feed the programme.

① there are no provision for punch tape and punch tape reader/writer.

② Only one Computer is used with one machine.

② One computer and several machines.

③ less production as compare to DNC machines.

③ large production in DNC system.

④ less Maintenance Cost

④ High Maintenance Cost

⑤ In CNC Computer

CNC

in integral part of machines

⑥ A Computer with normal configuration is used in CNC.

⑥ A Computer with advance configuration is used in DNC.

⑦ Remote operation is not possible in CNC.

⑦ DNC facilitates remote operation.

⑧ less floor area is required as compare to DNC

⑧ large floor area is required.

* Difference Between NC & CNC machine.

NC

CNC

① Input method in punch tape or punch card

① Input method is a part programme which is directly feeded to the computer.

② In case of any

② The programme

whole tape is to be replaced.

Can be modified to make any changes

③ Operation parameter can not be changed

③ operation parameter can be changed.

④ IT has no memory storage.

④ IT has ~~no~~ memory storage.

⑤ Tape is used just once to feed the programme.

⑤ Tape is used for each machine cycle.

⑥ NO feedback system.

⑥ IT has feedback system.

⑦ Low Maintenance is required.

⑦ High Maintenance is required.

⑧ The Cost of NC is low.

⑧ The Cost of CNC is high.

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CAD Workstation

CAD workstation, is the system interface with the outside world. It represent significant factor in determining how convenient and efficient it is for a designer to use the CAD system.

Functions of CAD workstation

① IT must interface with the CPU.

② IT must generate a study graphic image for the user.

③ IT must provide digital description of the graphic image.

④ IT must translate Computer Command in to operating function.

⑤ IT must facilitate Communication between user and it's system.

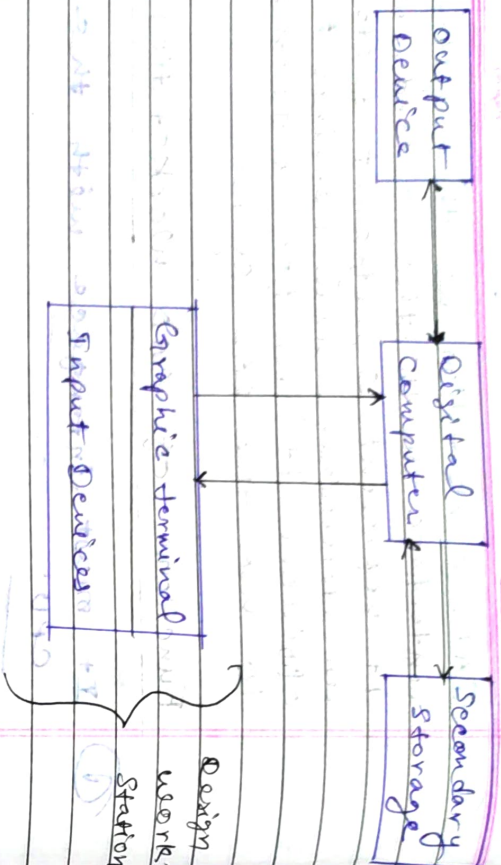


Fig. CAD Workstation

CAD Software

CAD Software is collection of Programme written to make it for user to operate the computer graphic system.

Function of CAD Software

1. Create Digital Model :- CAD Software can create digital model of product in 2D or 3D.

2. Represent Product Detail :- CAD

Software can represent a product dimension structure feature and

Strength.

3. Share and Review Design :- CAD Software allows user to share, review and modify design.
4. Simulate Design :- CAD Software allows user to simulate design.
5. Optimise for 3D Printing :- CAD Software can optimise 3D model for 3D printing.

6. Generate Compatible file format :- CAD Software can generate file format compatible with 3D printing.

Application of CAD Software.

1. Architecture
2. Aerospace
3. and transportation
4. Engineering and Construction
5. product Design and manufacturing
6. Civil Engineering and public Service.

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Types of CNC Machine

1. CNC Milling Machine :- CNC mills are machining centre equipped

with Computer Control to cut various material. They interpret programme containing specific number and letters enabling the spindle to move to different cut location and depth. These versatile machines are commonly used to create 3D prototype, moulds, cutting dies etc.

- ② CNC Lathe: CNC lathe specialize in cutting metal at high speed making rapid and precise cuts using indexable tools and complex programmes. They excel at that task that manual lathe can not handle, equipped with up to 12 tool holder and coolant pumps. CNC lathe effectively reduces tool wear and enable efficient metal working.

- ③ CNC Turning Machine: Turning centres are remarkable for executing multiple type of lathe cutting operation simultaneously on rotating part allowing for enhanced efficiency and productivity in machining process.

- ④ CNC Grinder: CNC Grinding machine utilise coated wheels to remove metal and safe parts with high precision gradually the incorporation of CNC technology has revolutionized the grinding process enabling greater accuracy and control.

- ⑤ CNC Drilling: CNC Drilling is ideal for mass production. It creates holes in various material. There are 2 common types of CNC Drill: ① Bench Drill ② Pillar Drill.

- ⑥ CNC Boring: CNC Boring enlarging existing holes or internally cylindrical surfaces. This can be achieved using lathe or especially designed machine like horizontal boring machine.

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Computer Aided Solid

Modelling & Assembly

Drawing Command (3D commands)

① Extrude ② Revolve ③ Sweep

④ Loft ⑤ Blend

① Extrude: Extrude Command is

used to extend polyline or Surface geometry entity along an arbitrary axis to add a depth dimension to the shape. An Extrude line would generate a Surface, an extrude surface would generate a volume. Volumes can not be extruded.

Steps to use Extrude Command

① Select the 3D modelling work-space.

② Select the Solid tab.

③ Select the Solid panel.

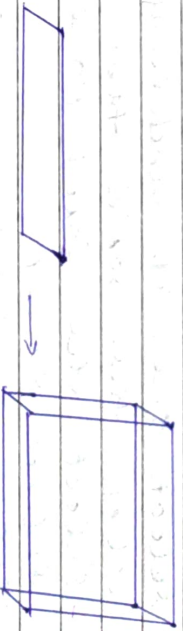
④ Select Extrude.

⑤ Select the object to extrude.

⑥ Specify height.

⑦ Press Enter.

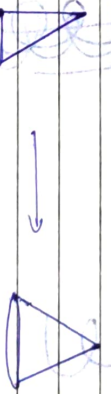
Example



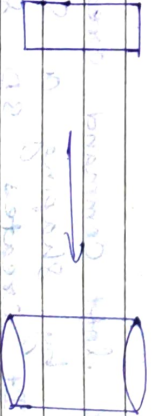
② Revolve Command: Revolve Command is

an auto cad creates a solid object by rotating a closed object around an axis. The axis can be a line, a linear polyline segment or a linear edge, at solid or surface steps used in revolve Command.

Example ①



②

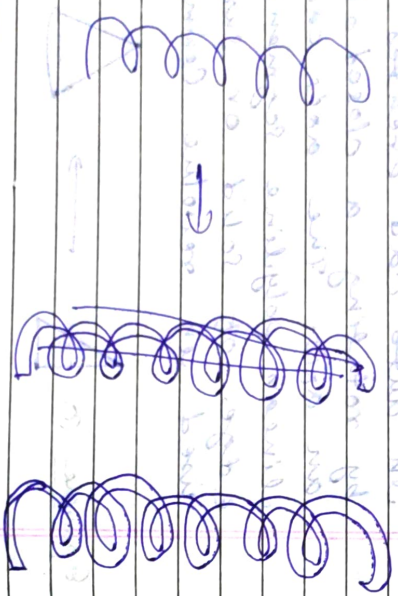


③ Sweep: Sweep Command is an auto cad

Creates 3D modelling Solid or Surface by extruding a 2D object along a path. This command can be used to create complex 3D geometries. Steps:-

- ① select the 3D modelling workspace.
- ② select the Solid tab.
- ③ select the Solid panel.
- ④ select Sweep.
- ⑤ select a object to sweep.
- ⑥ select a path to sweep along.
- ⑦ press Enter.

Example



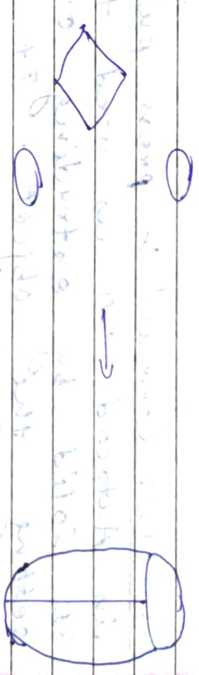
(4) loft. The loft Command creates a 3D object by shaping a Surface or Curve. It creates 3D Solid or Surface in the space b/w several cross section. defined the shape of the resulting solid surface.

Note:

Steps we use in loft Command:-

- ① Select the 3D modelling workspace
- ② Select the Solid tab.
- ③ Select the Solid panel.
- ④ Select loft Command.
- ⑤ Select the object to loft.
- ⑥ Select the Cross section.
- ⑦ It using path select the path.

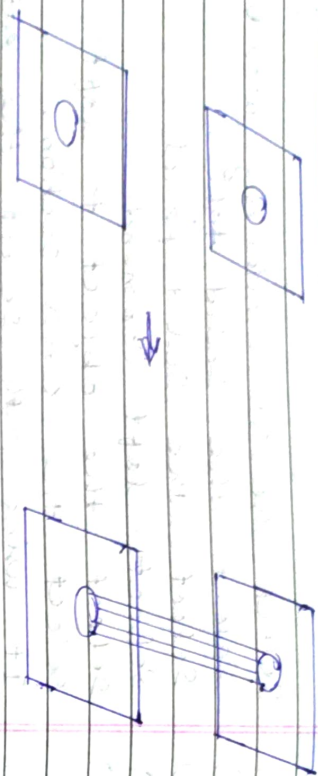
Example:



(5) Blend. Blend Command in Autocad creates a spline that connect two Selected line or curve. The spline shape, depends on the Continuity Specified.

* Steps used in Blend Commands:-

- ① Select the 3D modelling workspace
- ② Select the Solid tab.
- ③ Select the Solid panel.
- ④ Select Blend Command.
- ⑤ Select to curve or Arc.
- ⑥ Press Enter.

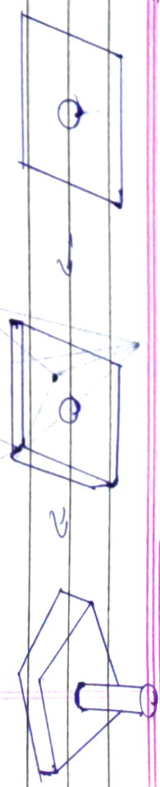


⑥ Pull Command :- Press pull Command in AutoCAD 3D is used to create 3D Solid by extruding or of setting the object. It also can be used to subtract part of the geometric create holes or applied height to the faces.

Steps used in pull Command

- ① Select the 3D modelling works
- ② Select the Solid tab.
- ③ Select the Solid panel.
- ④ Select pull Command.
- ⑤ click with in closed Area.
- ⑥ Break the mouse to indicate the direction of extrusion.
- ⑦ Enter the value to specific the extrusion distance.
- ⑧ Press Enter

Example

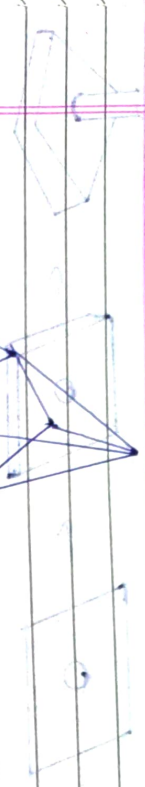


⑦ Union Command. Union Command in AutoCAD Combined two or more 3D Solids or Surfaces. in to a single Composite object. The resulting object is a closed region or solid.

Steps use in Union Command

- ① Select the 3D modelling works
- ② Select the Solid tab.
- ③ Select the Solid panel.
- ④ Select the Union Command.
- ⑤ Select the object to combine
- ⑥ Press Enter





Port Editing Commands:

- (1) Trim (2) Extend (3) Erase (4) Mirror
- (5) Chamfer (6) Round (7) Copy (8) Move
- (9) Draft (10) Hatch (11) Rotate

(1) Trim: Trim Command is used to trim objects to meet the edges of other object. Trim Command also can be used to erase segments of a line or curve between one or two intersecting sections.

Steps for using the Trim Command:

- (1) Select the boundaries and press enter
- (2) Select the object to be trim.
- (3) Press Enter.

(2) Extend: The extend Command

in AutoCAD extends the objects to meet edges of other objects. Extend Command can be used to extend lines, edges or other objects.

Steps: (1) Select the extend Command in the modify panel.

- (1) Select the object to extend.
- (2) Select the boundary for the object to extend.
- (3) Press Enter.

(3) Erase: Erase Command is used to erase the object. Steps:

- (1) Select the modify panel.
- (2) Select the Erase Command.
- (3) Select the object to erase.
- (4) Press Enter.

(4) Mirror: The mirror Command in AutoCAD creates a reverse copy of an object. This command also can be used to create half of the drawing.

and then mirror it to create

other half of the drawing.

Steps: ① Select the object to

mirror.

② Click mirror from toolbar.

③ Select 1st point of the mirror line.

④ Select 2nd point of the mirror line.

⑤ Press Enter.

⑤ Chamfer Command. Chamfer

Command in autocad creates any angled line that joins two straight 2D object.

Steps: ① Click the modify panel.

② Select chamfer

③ Select D at the specify distance.

④ Enter the 1st chamfer distance.

⑤ Enter the 2nd Chamfer distance

⑥ Select the 1st object.

⑦ Select the 2nd object.

⑧ Press Enter.

⑧ Rotate: Rotate Command in autocad is used to rotate the object at any angle.

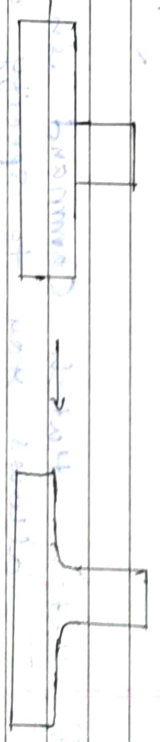
⑨ Fillet: Fillet Command in autocad rounds the corner of object to create a smoother look. It can be used to create round in 2D or 3D. Steps: ① Select the fillet Command.

② Set the fillet radius.

③ Select 1st object.

④ Select 2nd object.

⑤ Press Enter



② Copy: Copy Command in autocad copies existing drawing object in the current drawing.

① Select the object

② Press Control + C (Ctrl + C)

③ It needed Switch to the drawing where you want to paste the objects.

④ Press Control + V to paste the object.

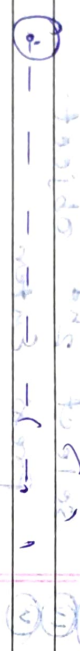
Example

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(9) Move: The move Command in autocad

move the object in specific direction and distance. Steps:

- (i) Select the move Command.
- (ii) Select the object to move.
- (iii) Press Enter.
- (iv) Specify a base point for the move.
- (v) Specify a 2nd point.



(10) Hatch: Hatch Command in autocad

allows you to specify a pattern to fill an area. You can use to hatch an Command to create custom pattern or use existing pattern.

Steps: (i) Select the Hatch Command.

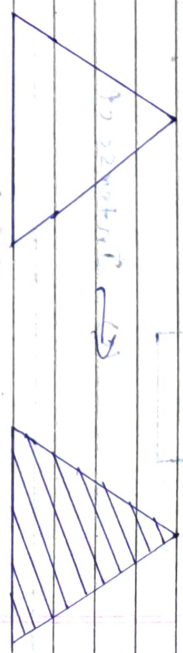
(ii) Choose the pattern you want to use.

(iii) Adjust to appear the pattern.

Scale and angles it needed.

(iv) Preview the pattern and accept it.

(v) Press Enter.



(ii) Boolean operation: Boolean operation

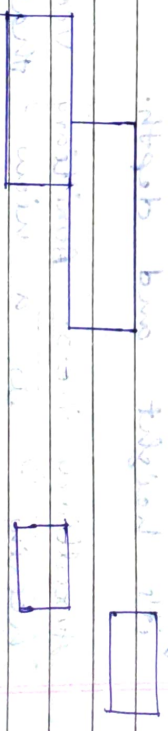
in autocad are used to Combine or modify the value of multiple variable. Types of Boolean operation is:

(i) Union: Combine multiple Solids in

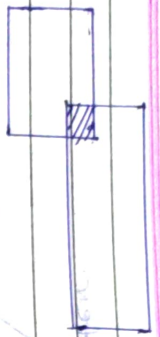
to one object.

(ii) Subtract: Remove one Solid from another.

(iii) Intersect: Create a new shape from a overlapping area of Solids.



(a) Union
(b) Subtract



(c) Intersect

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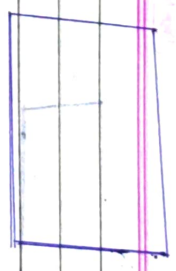
Computer Aided Drafting (CAD)

Front View: In Engineering Drawing the front view is a perspective in that shows an object as seen from the front.

Top View: Top View in Engineering drawing is a projection that shows what the top of an object would look like from directly above. It is also known as planned view.

Side View: Side View in Engineering drawing is a view of an object from the side which helps shows its height and depth.

Auxiliary View: Auxiliary View in Engineering drawing is a view that shows the true shape and size of an object inclined or oblique.



(c) Intersect

1. In AutoCAD, the 'Intersect' command is used to find the intersection of two objects. For example, if you have a circle and a line, the 'Intersect' command will create a new object at the point where they meet.

Dimensions in Auto-Cad

① Linear Dimension: The linear dimension tool measures horizontal or

Vertical distances:

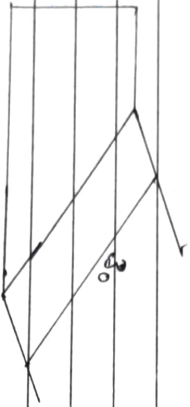
Vertical dimension

Horizontal dimension

To start the linear dimension tool from the command line, type dimlin press enter.

Aligned: The Aligned dimension tool measures the length along an object

Example

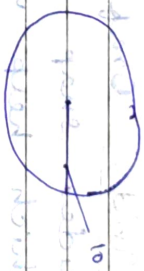


③ Angular Dimension tool: The angular dimension tool measures the angle between two objects. To start angular dimension tool from a command line - Type - DIMANG (short cut key)

④ ARC - length Dimension tool: The Arc length dimension tool measures the length of Arcs Type - Command - DIMARC - press Enter.

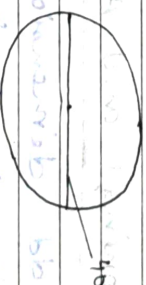
⑤ Radius: The radius dimension tool measures the radius of an arc or circle.

Command - DIMRAD - press Enter.



⑥ Diameter: The Diameter length dimension tool measures the length of Diameter of arc or circle.

Command -



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Drafting mode: In CAD drafting mode is a 2D design environment that allows users to create and edit 2D drawing and design.

Key Features of Drafting mode

① 2D Design - Drafting mode is pri-

mainly used for creating and editing 2D design such as floor plan, Elevation and Sections.

② Drawing Tool: The mode provides range of sketching drawing tool including line, arc, circle etc.

③ Snap and Grid: Drafting mode often includes snap and grid feature which help user to create precise drawing by snapping to specific point or aligning with grid.

④ Dimensioning and Annotation: User can add dimension text and other annotation to their drawing to provide context and clarity.

⑤ Layer Management: Drafting mode allows user to organise their drawing using layers which can be used to control visibility, colour, and other properties.

* Benefit of Drafting Mode

① Improved Accuracy
② Increased Efficiency
③ Enhanced Collaboration.

* Plot Scale
Plot scale refers to the ratio of the size of the plot to the actual size of the object being plotted.

Purpose

① Plot scale is used to ensure that the plot is proportional to the actual object making it easy to read and understand.

② Common types of scales are: Architectural, Engineering Scale, Metric Scale.

* Plot Area

Plot Area refers to the physical area of paper or media where plot will be printed.

Purpose

Plot area is used to define the boundaries of the plot ensuring that the plot fit within the available space.

* Plot Offset

Plot offset refers to the distance between the plot area and actual plot.

Purpose

- Plot offset is used to adjust the position of the plot with in the plot area, ensuring that the plot is centered or aligned as desired.

* Print Preview

Print preview is a feature in a CAD software that displays a simulated print out of design on the screen. It shows how the design will look when printed including the layout scale and other print settings.

* Plot Command

Plot Command is a feature in CAD software that allows you to print or export your design to various output devices, such as printer, platter, file formats like PDF, JPEG, etc. Common plot commands include plot scale, plot area, plot offset, plot orientation and plot devices.

Example -

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(Printer, Plotter etc.).

Automatic pallet changer (APC)

Automatic pallet changer (APC) is a device that enables a computer numerical machine (CNC) to automatically change pallet allowing for efficient and uninterrupted production.

* Role of APC

APCs are designed to reduce machine downtime by enabling rapid workpiece exchange by pre-loading workpiece on pallets. APC allows CNC machine to continue operation without waiting for manual set up or change over.

* Key Features of APC

- Pallet Magazine: Store multiple pallets which are organised in a specific order.

- Pallet Changer Mechanism: Retrieves

a pallet from the magazine and install it in the CNC machine.

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③ CNC Machine Interface

With the CNC machine to ensure seamless changes.

④ Control System: Control System

manage pallet changing process ensuring that correct plate is selected and installed.

★ Benefits of An APC

① Increased Efficiency: Automates

the pallet changing process reducing downtime and increasing productivity.

② Improved Accuracy: Ensure that

the correct pallet is used for each operation reducing error and improving part quality.

③ Reduce Labour Cost: Eliminates

the need for manual pallet changes freeing up operators to perform other tasks.

④ Enhanced Flexibility: Enabled

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CNC m/c to perform a wide range

of operation from simple to complex with minimal set-up and change over time.

★ Types of APC

① Single pallet APC: Single pallet

APC changes a single pallet at a time.

② Multiple pallet APC: Multiple pallet

APC changes multiple pallet at once increasing productivity and efficiency.

③ Robotic APC: Robotic APC deploy

robotic arm to change pallets providing flexibility and adaptability

★ Application of APC

① High Volume Production: APC are

ideal for high volume production environment where efficiency and productivity are crucial.

② Multi-tasking m/c: APC can be

used with multi-tasking m/c

which performs in a simple

Set up

* Multitasking M/C: APC can be used

with multitasking m/c which perform in a single set-up.

* Flexible Manufacturing System:

APC are often used in flexible manufacturing system where production requirement change frequently.

★ Working of APC

Step 1: Pallet Magazine loading:

(i) Pallet are loaded multiple pallet are loaded in to the pallet magazine.

(ii) Pallets are organised - pallets are organised in a specific order each pallet containing specific workpiece.

Step 2: CNC M/C Signal in APC, CNC

m/c Complete the current operation and signals the APC to

change the pallet. (The APC

receives signal from the CNC m/c and initiates the pallet changing process.)

Step 3: Pallet change process: (i) Pallet

Changer mechanism moves to CNC m/c pallet clamping system.

(ii) CNC pallet changer mechanism moves to or from the clamping

(iii) The pallet changer mechanism releases the pallet from the

pallet magazine.

(iv) The new pallet is installed in the CNC m/c pallet clamping system.

Step 4: CNC m/c resumes operation

with the new pallet and workpiece. (i) APC monitors the pallet change process and ensure that the new pallet is properly installed and clamped.

Step 5: Repeat cycle: the cycle repeat with the CNC m/c signalling the A/E to change the pallet when current operation is complete.

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Axis of CNC Machine

The reference to axes is used to describe CNC machine which operate along multiple axis point. CNC machining is the process of removing material from a workpiece until the desired shape is obtained. This machine have atleast 3 axes and operate along X, Y, Z plane.

The number of axis on a CNC machine determine the type of work it can do. The level of details it can cut and workpiece location it can manipulate.

CNC machine have ① 3 axis CNC m/c ② 4 axis CNC m/c ③ 5 axis CNC m/c.

④ 3 axis CNC m/c, 3 axis CNC

m/c implies that the workpiece remains in the same position while cutting tool operate along X, Y, Z plane to remove material.

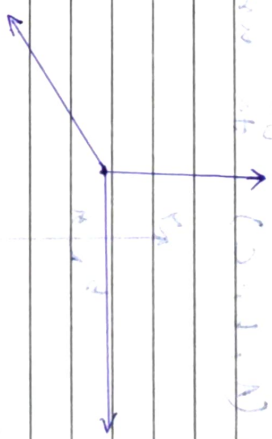
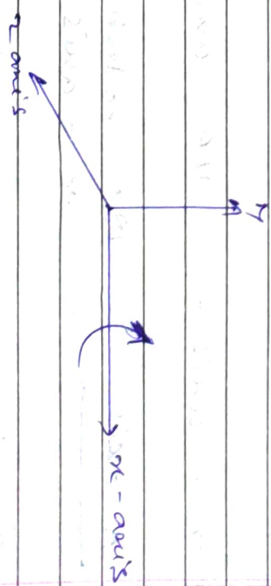


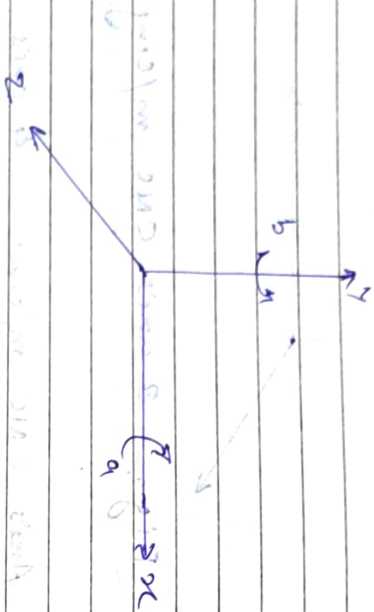
Fig. 1.1 3 axis CNC m/c

⑤ 4 Axis CNC m/c: 4 axis m/c implies that a workpiece is processed in the way it would be with 3 axis machine, but has an additional rotary movement around the X-axis.



⑥ 5 axis m/c: 5 axis m/c

implies that a manipulated arm can be automatically manipulated from 5 sides in one time. In addition to automatic movement along the X, Y, Z axis 5 axis CNC machine can select 2 of 3 rotational axis. (A, B, C) to use



Axis Movement

- ② X-axis - left to right
- ① Y-axis - front to back
- ① Z-axis - up and down

A axis - 180° rotation around X-axis

B axis - 180° rotation around Y-axis

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C-axis - 180° rotation around Z

CNC part programming

CNC part programming is a detailed list of instructions that need to be executed by the machine control unit to achieve the final component. Following steps involved in development of part programming

- ① process planning: process plan is detailed plan of steps involved in manufacturing a given part. Following are the contained of process plan
 - ② machine tools used
 - ③ fixtures required
 - ④ sequence of operation

② Axis selection / Tool path Selection

Axis selection is a critical step in the CNC machining. It determines the orientation and movement of the cutting tool in relation to the workplace. Axis system describes the axis motion for necessary tools established.

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3) Tools Selection: Choose tool for each

operate cutting tool for each operation. Consider factors such as material type, cutting speed, tool life etc. The right tool contributes significantly to the efficiency and quality of the machining process.

4) G-Code programming: write the

G-Code programming from the CAD Software and see how the G-Code Commands affect the machine work. pay close attention and know the basics of CNC programming for the steps.

5) work - Co-ordinate System / i. Simula-

ting the programme: After creating the programme take it in the CAD Software Simulation to catch any potential problems before using the CNC machine for real. This helps prevent mistakes and ensure smoother production.

6) Post processing: Once you finish

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the programme the CAD Software to make the final G-Code, the G-Code has instructions the CNC machine needs to make the part you want.

7) Transfer the programme: Sent

the G-Code programme to the CNC machine.

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CNC Work - Holding

General

Work holding devices are essential in CNC milling to secure the work-piece, ensuring stability, accuracy and repeatability. The choice of work holding devices depends on the milling process, workpiece geometry and production volume.

1 CHUCK

(a) 3 Jaw Chuck: Self centering chuck ideal for round or hexagonal workpiece in lathe operation.

(b) 4 Jaw independent: - Allows individual Jaw movement useful for irregular shapes.

(c) Collect Chuck: provides high precision for holding small cylindrical parts.

(d) Magnetic Chuck: Uses magnet to hold the ferrous material.

(2)

Vice

(a)

Standard

machines

Vice - used for General milling and Drilling.

(b)

Precision vice - offers higher accuracy for fine machining

(c)

Angle vice: Allows tilting for angled machining.

(d)

Self Centering vice: Centres the workpiece automatically useful for Symmetrical parts.

(3)

Mandrel and Arbour. (a) Expanding

mandrel - used for internal gripping of cylindrical parts.

(b)

Taper Mandrel: used for conical parts.

(4)

Palat System: (a) Manual Palat

System - Allow quick workpiece changeover.

(b)

Automatic Palat changer: used

for high volume CNC production for efficiency.

5

Fixture, (a) Vacuum Fixture, (b) Used

Suction to hold theme. or delicate workpiece.

(b) Dedicated Fixture: Reconfigurable to accommodate different workpiece.

6

Clamp: (a) Toe clamp

7

Step clamp (b) Toggle clamp

8

Tool Holding Devices: Tool Holding

devices in CNC machining, ensuring cutting tool in place ensuring precision, stability and repeat-ability.

The choice of tool holder depends on factor like, spindle type, tool size, machining operation and accuracy requirement.

9

Collect chuck: - Uses a collect to

grip the tool shank. Advantage: (i) High clamping force (ii) Excellent Accuracy

10

Reduce tool vibration.

11

Hydraulic Tool Holder: Uses hydraulic pressure to clamp the tool shank. Advantage

12

Excellent vibration damping

13

High precision (3) Easily tool change.

14

Application:

15

High speed machining and precision cutting.

16

Drill chuck: A Simple clamping device that hold drill bit.

17

Advantage

18

Easy to use (ii) Versatile and suitable for low to moderate precision task.

19

Application: (i) Drilling and Reaming operation

20

Morse Taper Holder: Morse Taper holder uses a safe locking taper to hold the tool. Advantage (i) Simple in design (ii) Good for high force application (iii) Provide strong holding power

21

Application: Heavy duty drilling and boring operation.

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Shrink Fit tool Holder: Uses thermal

Expansion to grip the tool with the tool inserted when the holder is heated. Advantage: (i) Superior accuracy for high speed application.

APP: (i) Aerospace (ii) Automotive (iii) and high precision industry.

(6) End mill Holder: Uses a set screw to secure the flat portion of an end mill. Advantage: (i) Strong grip (ii) Suitable for high torque

APP: (i) Milling operations of steel

(7) Hollow Shank taper Holder: Uses a

hollow taper for high speed precision clamping. Advantage: (i) High rigidity

(ii) Better Accuracy (iii) Faster tool changes.

APP: High speed m/c in aerospace and automotive industry.

★ CNC Tool Pre-setting

CNC Tool pre-setting is a process

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of measuring and setting tool dimension.

Such as Length and diameter before loading them in to CNC m/c. This ensures precision, reduces set up time and minimizes machining error.

★ Types of Tool pre-setting

(i) Offline tool pre-setting: External

tools pre-setting. Tools are measured using separate tool pre-setter outside the CNC machine. Data is transferred to the CNC machine via manual entry, bar code or direct digital communication.

(ii) Online Tool pre-setting: Tools

are measured inside the CNC machine using the tool probe. The m/c automatically records tool offset.

This advances devices utilize technologies such as cameras, sensors, or touch probes to automatically measure and set tool with high precision and speed. They often integrate directly with the CNC m/c for seamless data transfer.

★ Importance of Tool Pre-Setting

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① Increased Machine up time:- Measuring tools offline allows the CNC m/c to continue operating while tools are being prepared. Reducing down time and enhancing productivity.

② Improved Accuracy and quality:- Precise measurement of tool dimensions ensure that the correct offset are applied leading to higher machining accuracy and better part quality.

③ Extended Tool life:- properly pre set tool experience reduced run out and wear which can prolong their lifespan and reduce truly cost.

④ Enhanced Safety:- Accurate tool measurement minimize the risk of collision or errors during machinery machining contributing to safer working environment.

Implementing tool pre setting in CNC machining streamline the set up process, enhances machine accuracy and optimize overall manufacturing efficiency.

★ Quality of Tool in CNC

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A Qualified tool in CNC machining is a cutting tool that has been measured calibrated and its dimensions are already known. and stored in the CNC system. when a qualified tool is mounted there is no need to remeasure it manually before machining because CNC m/c already has its exact offset values saved.

★ Need For Qualified Tool

① Fast Set up- Reduce the time needed for tool changes and m/c setup.

② Repeatability- Ensure consistent tool placement and machining accuracy everytime the tool is used.

③ Minimized downtime:- Eliminate the need to measure tool offset repeatedly keeping the m/c running efficiently.

④ Standardization- It helps maintain uniform quality across multiple m/c or jobs using tool with known parameter.

★ Advantage of Qualified tool

①

Increased Productivity, tools to use immediately, No manual measurement needed.

②

High precision, Accurate and Consistent result, specially useful for complex or repeat jobs.

③

Better workflow, Simplifies tool management and improve scheduling in production.

④

Less operator error, Reduces chance of human mistake during tool set up.

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G- Codes

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G00

Rapid positioning

G01

Linear interpolation

G02

Circular interpolation (CWI)

G03

Circular interpolation (CCW)

G04

Dwell (Pause)

G17

XY Plane Selection

G18

ZX Plane Selection

G19

YZ Plane Selection

G20

Inch mode

G21

Metric mode

G28

Return to home position

G90

Absolute programming

G91

Incremental programming

G92

Set current position

G98

Return the tool to the initial (starting) point after completing a canned cycle.

M - Codes

G81	drilling	M00	Programme stop
G83	feed Drilling	M01	Optional stop
G84	Tapping	M02	End of program
G85	Boring	M03	Spindle ON (Clockwise)
G99	Faster operation, less retraction	M04	Spindle ON (C. clockwise)
G98	G81 X50 Y50 Z-10 R5 F100	M05	Spindle Stop
G81	= Drilling cycle	M06	Tool change
G98	= Return to initial Z level after drilling	M08	coolant ON
Z-10	= Drill depth	M09	coolant OFF
R5	= Rapid to 5mm above surface	M30	End of Programme and reset
F100	= Feed rate	M07	Mist Coolant ON

CNC WORK HOLDING DEVICES

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Devices

① Chuck ② 3 jaw chuck

③ 4 jaw independent chuck

④ Collect chuck

⑤ Magnetic chuck

⑥ VICE ① Standard vice

⑦ Precision vice ② Angle vice

⑧ Self Centric vice

⑨ Mandrel and Armour

⑩ Expanding mandrel

⑪ Taper mandrel

⑫ Paliet system

⑬ manual paliet

⑭ Automatic paliet changer (APC)

⑮ Fixture :- ① vacuum

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⑯ Dedicated Fixture

⑰ Clamp :- ① Toe clamp

⑱ Step clamp ② Toggle clamp

Tool holding Devices

① Collect chuck

② Hydraulic Tool Holder

③ Drill chuck

④ Morse Taper Holder

⑤ Shrink Fit Tool Holder

⑥ End Mill Holder

⑦ Hollow Shank Taper Holder

CANNED cycle :-