

★ Basics of CNC programming:

Word Address format: Words in an instruction block are intended to convey command needed for machine tool to execute specific operation.

Sequence of word in a block: We have to write program in sequence

- Sequence no. or sequence word (N-word)
- Preparatory word (G-word)
- coordinates (X, Y, Z - Linear & A, B, C - Rotation)
- Feed rate (F-word)
- Spindle rotation or spindle speed (S-word)
- Tool selection (T-word)
- Miscellaneous commands (M-word)
- End of block (EOB-Symbol)

★ G-Codes:

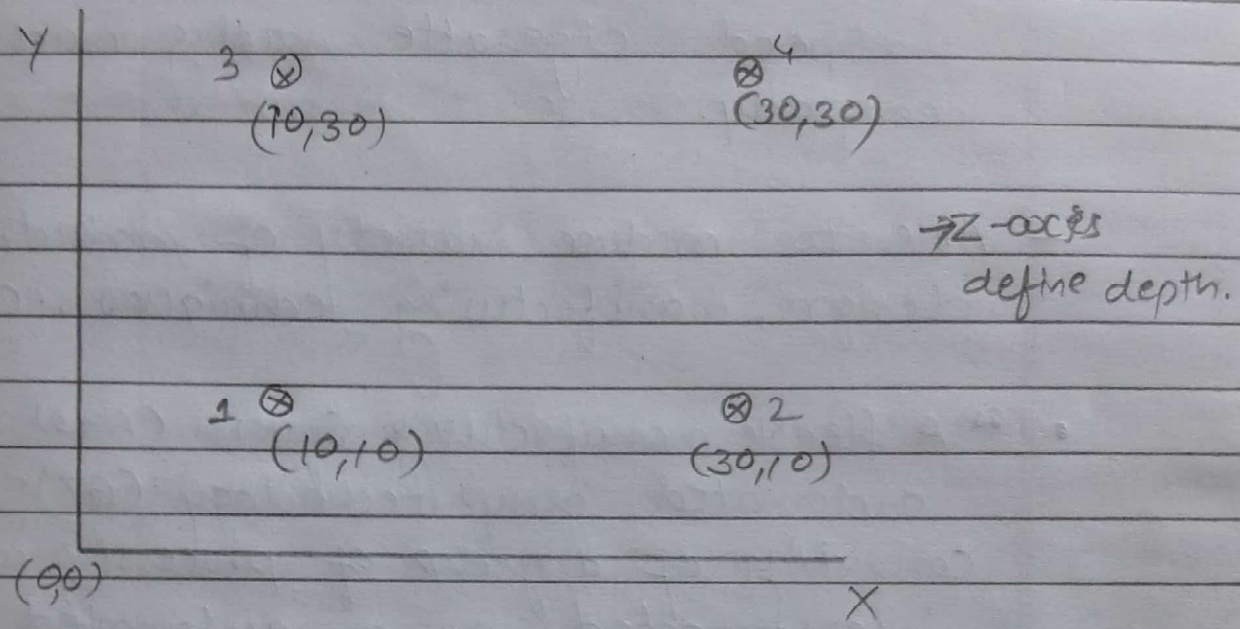
code	Description/feature
G00	- Point to point movement (Rapid travel) b/w previous point & end point. - It must include X, Y, Z coord. of end point.

G01	- Linear interpolation movement. - It must include x, y, z coord. of end point & feed rate.
G02	- Circular interpolation (clockwise) - Block must include either arc radius or arc centre and coord. of endpoint - Feed rate required.
G03	- Circular interpolation (counter clockwise) - Block must include either arc rad. or arc centre and coord. of end point. - Feed rate.
G20	- Input values specified in inches.
G21	- Input values specified in mm.
G90	- Programming in absolute coord.
G91	- Programming in incremental coord.
G92	- Specify location of coord. axes system, origin relative to starting location of cutting tool.
G94	- Specify feed per min (milling & drilling)
G95	- Specify feed per revolution (milling & drilling)
G98	- Specify feed per min (Turning)
G99	- Specify feed per revolution (Turning)

★ M-Codes:

Code	Description / function
M03	- Start spindle in clockwise direction.
M04	- Start spindle in anti-clockwise direction.
M05	- Spindle stops.
M06	- Execute tool change.
M13	- Start spindle in clockwise direction & turn on cutting fluid.
M14	- Start spindle in anti-clockwise direction & turn on cutting fluid.
M17	- Spindle & cutting fluid off.
M30	End of program (machine stops)

Ques: Write prog. to drill on a workpiece in specified coord. ✓



- Generally all direction distances are in mm.
- Origin is always take away from starting point.
- Cutting tool is placed (rapidly), 2mm above from the working material to avoid breakdown of tool.

Prog:

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N005 G21 G90 G00 X10 Y10 Z10;
10 S1000 M03;
15 G00 Z2;
20 G95 G01 Z-10 F0.05;
25 G95 G01 Z2 F0.10;
    
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★ Flexible Manufacturing System (FMS)

- In 1960's, David Williamson use FMS for high speed cigarette making machine in Molin company.
- Able to produce variety of products, by changing design, manufacturing techniques, cell etc.
- "A flexible manufacturing system (FMS) is a highly automated group technology (GT) machine cell consisting of a group of processing workstation, interconnected by an automated material handling & storage system and controlled by a distributed computer system."

AS/RS: Automated storage & retrieval system.

Why FMS is flexible? The reason behind the flexibility of FMS is that, it is capable of processing a variety of different parts type simultaneously at different workstation. The mix of parts style and quantities of production can be adjusted in response to change in demand pattern.

- FMS is most suitable for mid variety and mid volume production range.

Classification of FMS

- To qualify as being flexible a manufacturing system should satisfy several criterion (Test of flexibility)

(i) Part variety test:

Can the system process different parts style in a non batch mode

(ii) Schedule change test:

Can the system readily accept changes in production schedule and changes in either parts mix or production quantities.

(iii) Error recovery test:

Can the system recover gracefully from equipment breakdown so that production is not completely disrupted or stopped.

(iv) New part test:

Can new part design be introduced into existing product mix with relative ease.

Note: If the automated system does not meet atleast 3 test, it should not be classified as FMS.

* Types of flexibilities:

- (i) Machine flexibility: Capability to adapt a given machine in the system to a wide range of production operation.
- (ii) Production flexibility: The range of parts style that can be produced.
- (iii) Mixed flexibility: Ability to change the product mix while maintaining the same production quantities.
- (iv) Product flexibility: Each with which design changes can be accommodated.
Each with which new product can be produce.
- (v) Routine flexibility: Capacity to produce parts through alternative workstations sequences in response to equipment breakdown (tool failure).
- (vi) Vol^m flexibility: Ability to produce parts economically in high & low quantities.
- (vii) Expansion flexibility: Easy with which the system can be expanded to increase total production.

★ Comparison of 4 Criterion of flexibility in manufacturing system with the 7 types of flexibility

Flexibility test	Type of flexibility
(i) Part variety test	- Production. - Machine.
(ii) Schedule change test	- Expansion. - Mix. - Vol ^m .
(iii) Error recovery test	- Routine.
(iv) New part test	- Product.

★ Types of flexible Manufacturing System:

(i) Based on No. of machine.

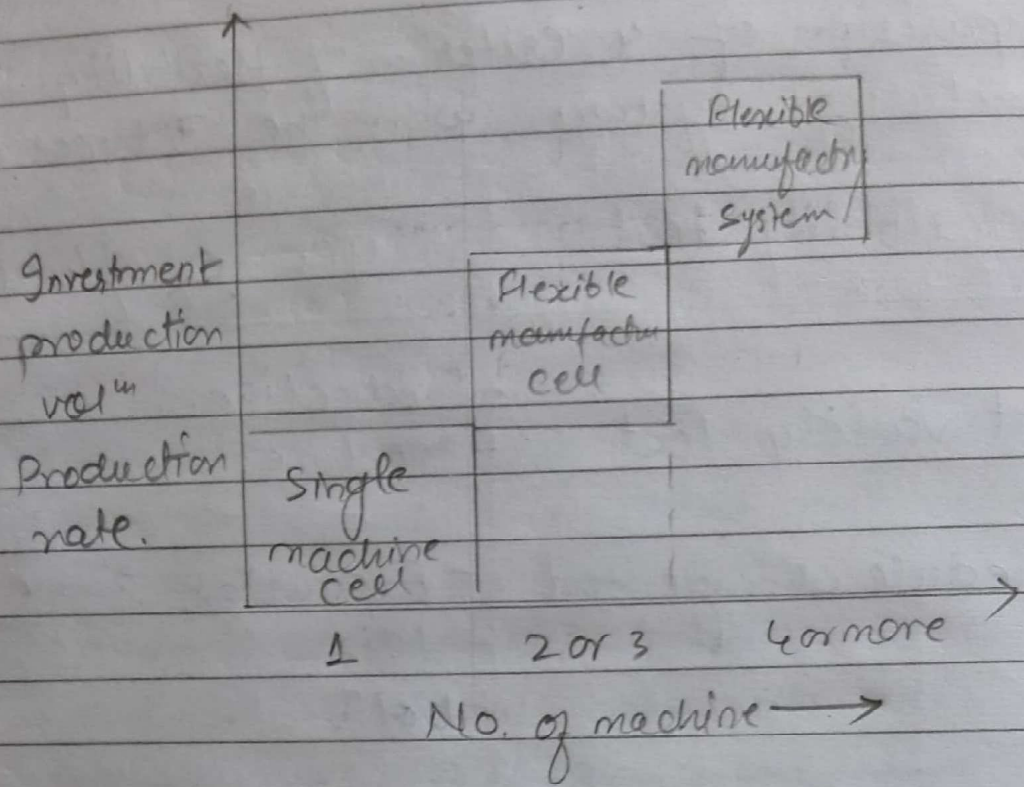
(a) Single machine cell: It does not satisfy error recovery test.

(b) Flexible manufacturing cell: It satisfy all 4 test.

It contains 2 to 3 machine or workstation, along with part entering system.

(c) Flexible manufacturing systems It satisfy all 4 test.

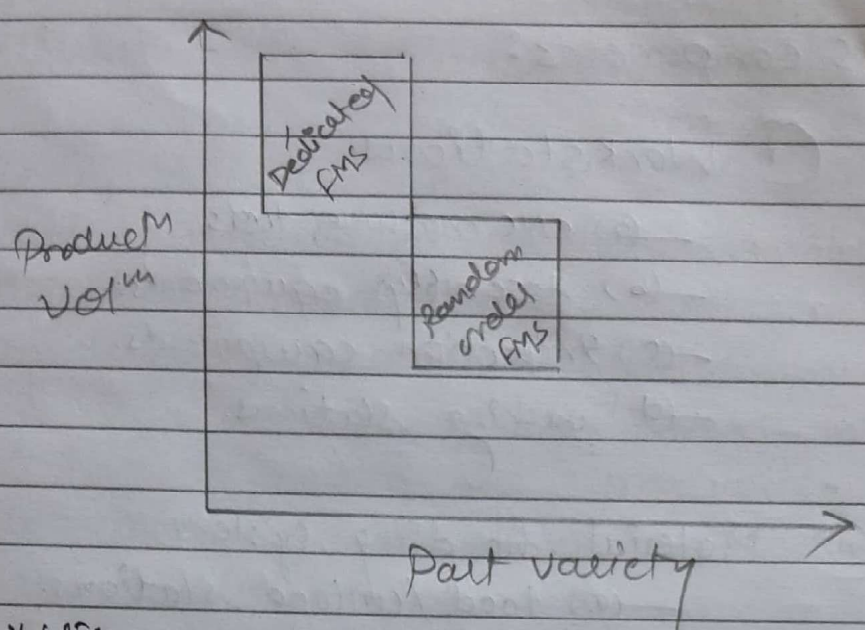
It has 4 or more workstation connected mechanically by a common part handling system and electronically by a distributed computer system.



(n) Based on level of flexibility:

(a) Dedicated FMS: A dedicated FMS is design to produce a limited variety of parts and cell parts to be made one system are known in advance.

(b) Random order FMS: A Random order FMS is more appropriate when the part family is large. and there is sustaintical change in part configuratⁿ, introducing new part design, day-to-day change in production schedule. It is equiped with general purpose machine to deal with variation in part design and demand fluctuation.



* Flexibility criterion apply to types of FMS based on no. of machine & level of flexibility.

System types	Flexibility criterion			
	Part variety	Schedule change	Error recovery	New Part
Single manufacturing cell	Yes	Yes	No (limited recovery)	Yes
Flexible manufacturing cell	Yes	Yes	Yes (error recovery limited by fewer machine than FMS)	Yes
Flexible manufacturing system	Yes	Yes	Yes (machine redundancy minimises effect of machine break-down)	Yes
Dedicated FMS	Limited (all part known in advance)	Limited changes can be tolerated	Limited by sequential process	No (New part introduction is difficult)
Random order FMS	Yes	Frequent changes can be possible	Machine redundancy minimises effects of machine break down	Yes

★ FMS components:

① Workstations

- (a) CNC machine tools
- (b) Assembly equipments.
- (c) Inspection equipments.
- (d) washing stations.

② Material handling system.

- (a) load/unload stations.
- (b) AGVS
- (c) AS/RS

③ Control System.

- (a) Monitoring equipments
- (b) network
- (c) production control, traffic controls.

④ Tool system.

- (a) Tool setting station
- (b) Tool transport system.

★ Benefits of FMS:

- ① Increase machine utilisation
- ② Fewer machine required.
- ③ Reduction in factory floor space required.
- ④ Reduce inventory requirement.
- ⑤ Lower manufacturing lead time.
- ⑥ Reduce direct labour requirements.
- ⑦ Higher labour productivity

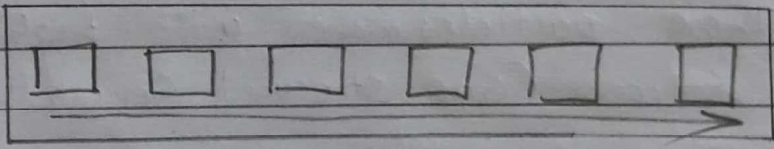


Cellular manufacturing: cellular manufacturing works on group technology, in which similar parts are identified and grouped together to take advantages of their similarities in design & production.

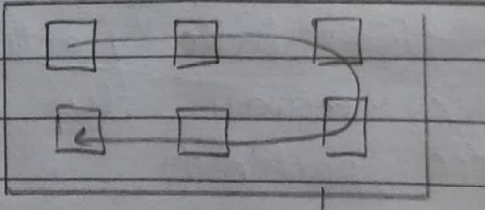
Grouping the production equipments into machine cell where each cell specialised in the production of part family, is called cellular manufacturing.

→ These are 3 types of machine cell design.

(i) Straight or inline cell



(ii) U-shape cell



(iii) L-shape cell

