

# School of Mechanical Engineering

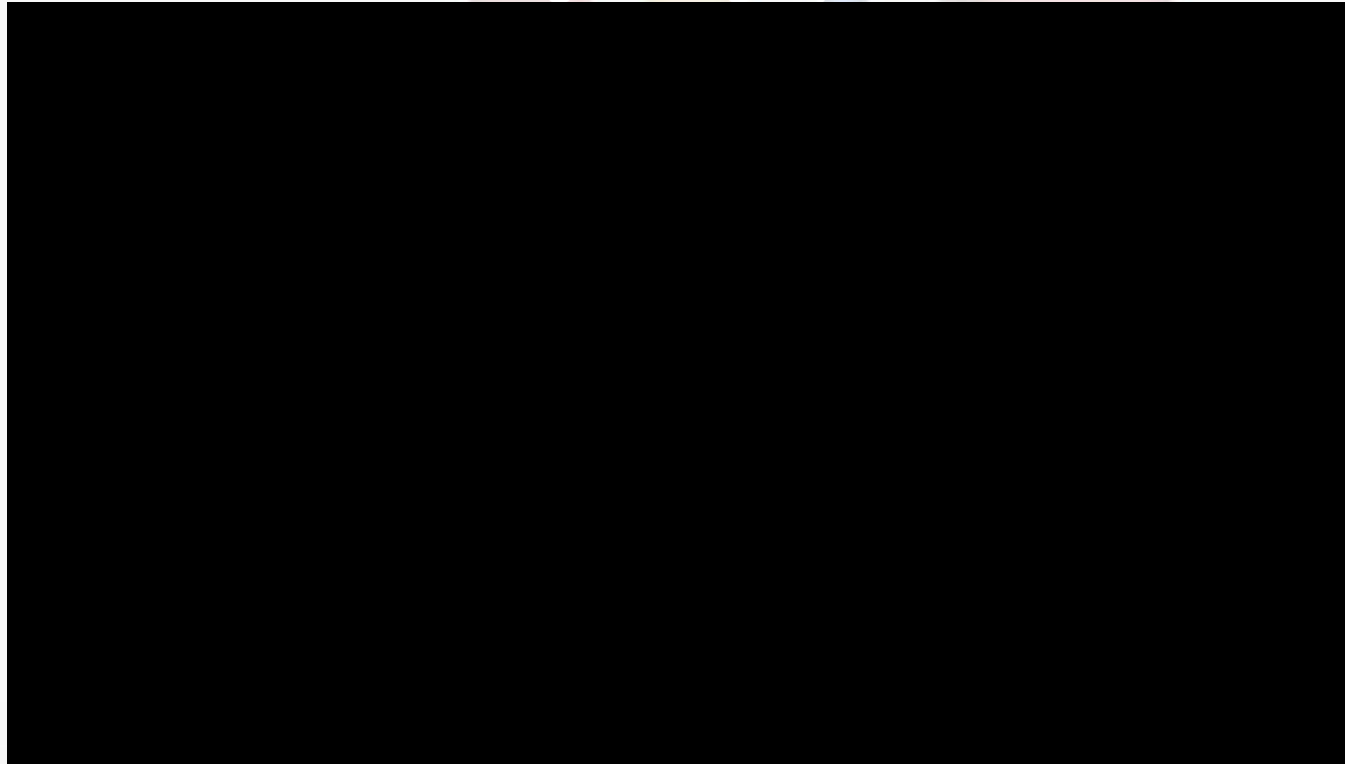
Course Code : BAUT4001

Course Name: CAD/CAM

## UNIT - 3

### CNC Machine Tools

10/ Programming Key Letters



Name of the Faculty: Mr. Shrikant Vidya

Program Name: B.Tech (Auto)

# School of Mechanical Engineering

Course Code : BAUT4001

Course Name: CAD/CAM

## CONTENTS

1. History
2. CNC Introduction
3. how they look like?
4. Elements of CNC
5. Block diagram of CNC
6. How CNC Works?
7. Features of CNC Machines
8. CNC Programming Basics
9. Common Format of a Block
10. Programming Key Letters
11. Table of important G-codes
12. Table of important M-codes
13. Advantages
14. Challenges
15. Conclusion
16. References

Name of the Faculty: Mr. Shrikant Vidya

Program Name: B.Tech (Auto)

## History

- The first NC machines were built in the 1940s and 1950s by Prof. John T Parson.
- CNC machine came into existence after evolution of computer around 1980.
- Modern CNC Machine are improving further as the technology is changing with a variety of functions according to applications.

## CNC Introduction

A numerical control system in which the data handling, control sequences, and response to input is determined by an on-board computer system at the machine tool.



# School of Mechanical Engineering

Course Code : BAUT4001

Course Name: CAD/CAM

## CNC Machines- How do they look like?



Name of the Faculty: Mr. Shrikant Vidya

Program Name: B.Tech (Auto)

## Elements of CNC Machine

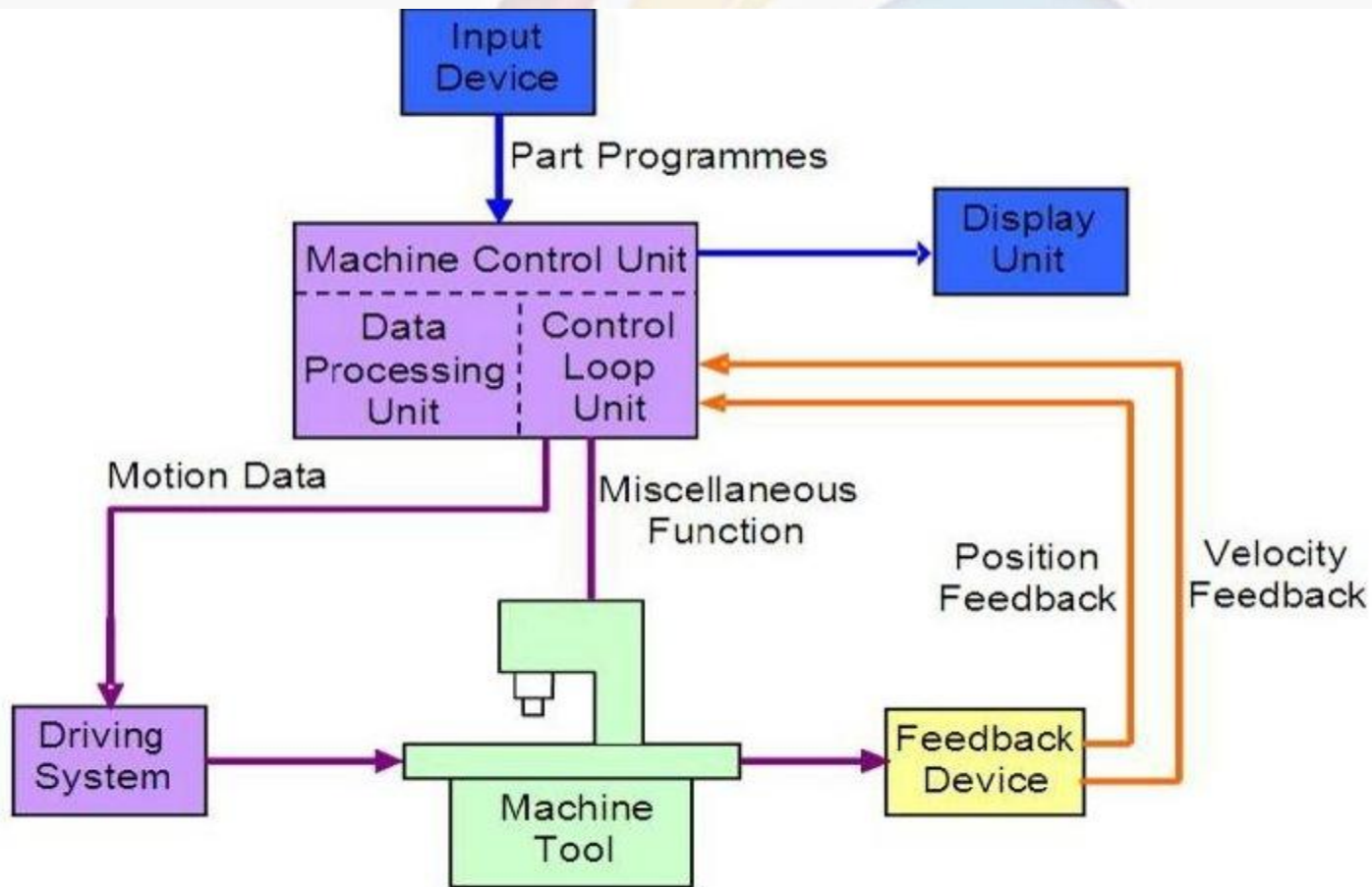
- A CNC machine consist of following 6 major elements:
  - i. Input Device
  - ii. Machine Control Unit
  - iii. Machine Tool
  - iv. Driving System
  - v. Feedback Devices
  - vi. Display Unit

# School of Mechanical Engineering

Course Code : BAUT4001

Course Name: CAD/CAM

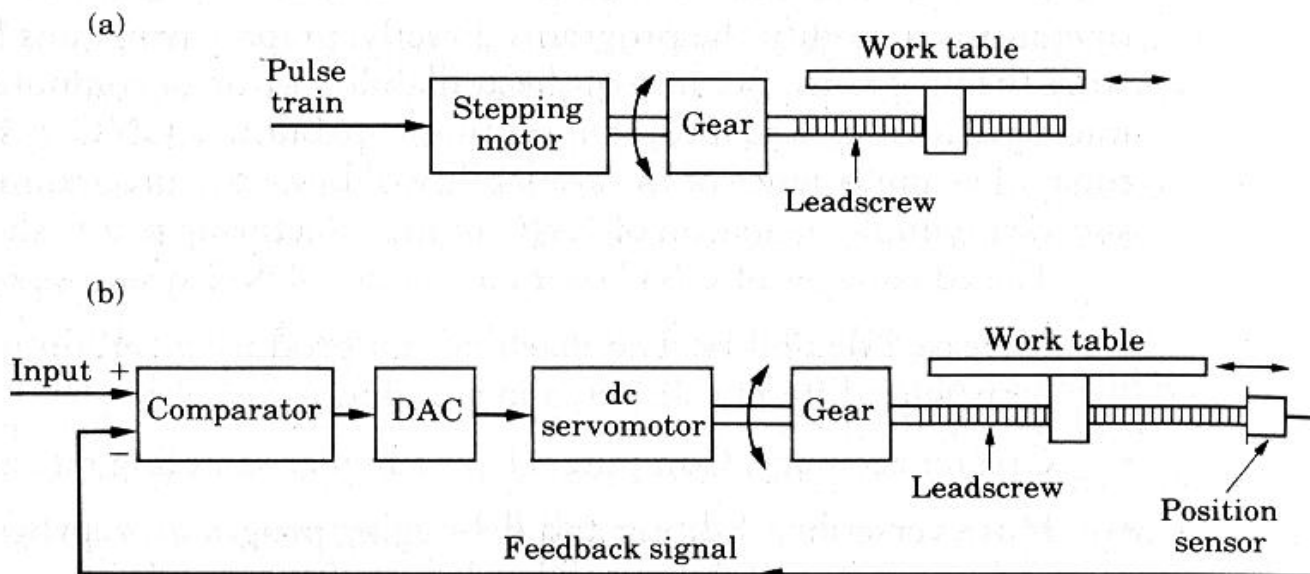
## Block diagram of CNC Machine



Name of the Faculty: Mr. Shrikant Vidya

Program Name: B.Tech (Auto)

## Open loop and Closed loop controls



In open loop systems the slide may overshoot or may not reach desired position because of inertia, wear and tear and friction, hence inaccurate machining.

In closed loop systems the position sensors are used to correct slide movements and achieve higher accuracy and repeatability



## How CNC Works

- Controlled by G and M codes.
- These are number values and co-ordinates.
- Each number or code is assigned to a particular operation.
- Typed in manually to CAD by machine operators.
- G & M codes are automatically generated by the computer software.

GALGOTIAS  
UNIVERSITY

## Features of CNC Machinery

- The tool or material moves automatically.
- Tools can operate in 1-5 axes.
- Larger machines have a machine control unit (MCU) which manages operations.
- Movement is controlled by motors (actuators).
- Feedback is provided by sensors (transducers)
- Tool magazines are used to change tools automatically.

## CNC Programming Basics

- CNC instructions are called part program commands.
- When running, a part program is interpreted one command line at a time until all lines are completed.
- Commands, which are also referred to as blocks, are made up of words which each begin with a letter address and end with a numerical value.

## CNC programming

Important things to know:

- Coordinate System
- Units, incremental or absolute positioning
- Coordinates: X,Y,Z, RX,RY,RZ
- Feed rate and spindle speed
- Coolant Control: On/Off, Flood, Mist
- Tool Control: Tool and tool parameters

Programming consists of a series of instructions in form of letter codes

•Preparatory Codes:

G codes- Initial machining setup and establishing operating conditions

N codes- specify program line number to executed by the MCU

•Axis Codes: X,Y,Z

Used to specify motion of the slide along X, Y, Z direction

•Feed and Speed Codes: F and S

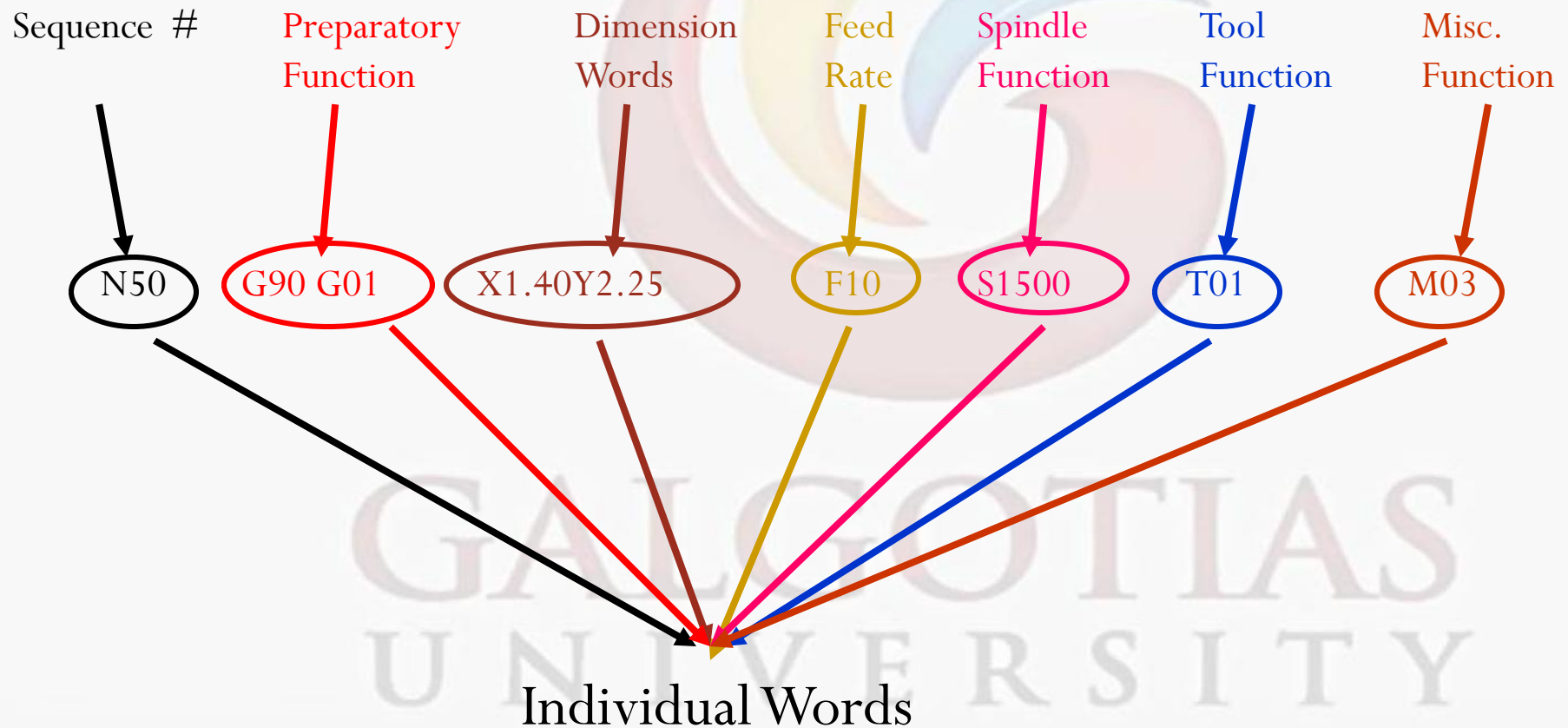
Specify feed and spindle speed

•Tool codes: T – specify tool number

•Miscellaneous codes – M codes

For coolant control and other activities

## Common Format of a Block



## Programming Key Letters

- O - Program number (Used for program identification)
- N - Sequence number (Used for line identification)
- G - Preparatory function
- X - X axis designation
- Y - Y axis designation
- Z - Z axis designation
- R - Radius designation
- F – Feed rate designation
- S - Spindle speed designation
- H - Tool length offset designation
- D - Tool radius offset designation
- T - Tool Designation
- M - Miscellaneous function

# School of Mechanical Engineering

Course Code : BAUT4001

Course Name: CAD/CAM

## Table of Important G codes

G00 Rapid Transverse  
G01 Linear Interpolation  
G02 Circular Interpolation, CW  
G03 Circular Interpolation, CCW  
G17 XY Plane,G18 XZ Plane,G19 YZ Plane  
G20/G70 Inch units  
G21/G71 Metric Units  
G40 Cutter compensation cancel  
G41 Cutter compensation left  
G42 Cutter compensation right  
G43 Tool length compensation (plus)  
G43 Tool length compensation (plus)  
G44 Tool length compensation (minus)  
G49 Tool length compensation cancel  
G80 Cancel canned cycles  
G81 Drilling cycle  
G82 Counter boring cycle  
G83 Deep hole drilling cycle  
G90 Absolute positioning  
G91 Incremental positioning

Name of the Faculty:Mr. Shrikant Vidya


Program Name: B.Tech (Auto)

## Table of Important M codes

- M00 Program stop
- M01 Optional program stop
- M02 Program end
- M03 Spindle on clockwise
- M04 Spindle on counterclockwise
- M05 Spindle stop
- M06 Tool change
- M08 Coolant on
- M09 Coolant off
- M10 Clamps on
- M11 Clamps off
- M30 Program stop, reset to start



## Advantages of CNC

- 
- i. - Easier to program;
  - ii. - Easy storage of existing programs;
  - iii. - Easy to change a program
  - iv. - Avoids human errors
  - v. - CNC machines are safe to operate
  - vi. - Complex geometry is produced as cheaply as simple ones
  - vii. - Usually generates closer tolerances than manual machines
- GALGOTIAS  
UNIVERSITY

# School of Mechanical Engineering

Course Code : BAUT4001

Course Name: CAD/CAM

## Challenges

- i. Costly setup, skilled operators
- ii. Computers, programming knowledge required
- iii. Maintenance is difficult

GALGOTIAS  
UNIVERSITY

Name of the Faculty: Mr. Shrikant Vidya

Program Name: B.Tech (Auto)

## Conclusion

- The advantage of a CNC system are that the operation of a conventional machine is removed and the part production is made automatic.
- It reduces the labor work and hence highly efficient in the manufacturing process.
- BHEL generally uses CNC machines to achieve its manufacturing targets. For manufacturing works of large scale it is very difficult to work with manual machines as they are time consuming. CNC machines have their wide scope because they are easy to handle, the work becomes easier and jobs are done with perfection.

# School of Mechanical Engineering

Course Code : BAUT4001

Course Name: CAD/CAM

The logo of Galgotias University is a stylized 'G' composed of several curved, overlapping bands in shades of red, yellow, and blue, creating a sense of motion and energy.

Thank You

GALGOTIAS  
UNIVERSITY

Name of the Faculty: Mr. Shrikant Vidya

Program Name: B.Tech (Auto)