

# *Automation (21-541)*

*Advanced Manufacturing Laboratory  
Department of Industrial Engineering  
Sharif University of Technology*

*Session # 15*



## *Session Schedule*

- *Computer-Aided Manufacturing (CAM)*
  - *Introduction*
    - *Manufacturing automation primitives*
  - *CNC machining*
    - *Introduction to CNC machining*
    - *Types of CNC machines*

## Computer-Aided Process planning (CAPP)

- *Process planning primitives*
  - *Process planning is concerned with determining the sequence of individual manufacturing operations needed to produce a given part or product.*
  - *The resulting operation sequence is documented on a form typically referred to as operation sheet.*
  - *The operation sheet is a listing of the production operations and associated machine tools for a work part or assembly.*
  - *Process planning is an important stage of product development since production tool jigs, fixtures, special tools etc. can be designed only after the process plan is finalized.*



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## Computer-Aided Manufacturing (CAM)

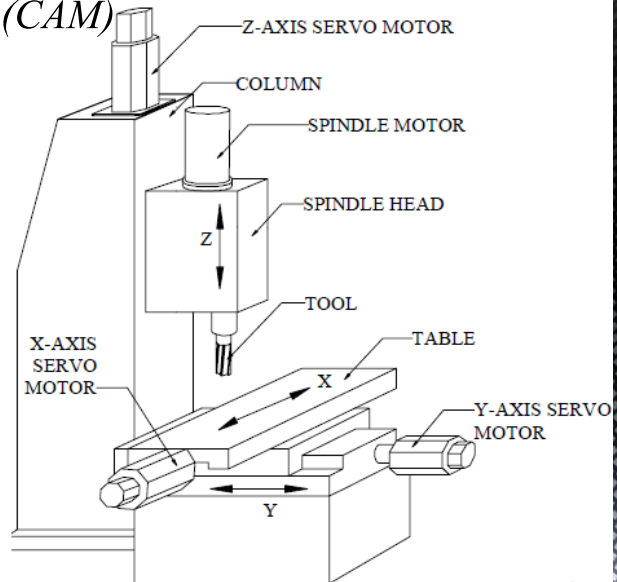
- *Manufacturing automation primitives*
  - *CNC machining*
    - *Numerical control (NC) was developed in early 50's to meet the critical requirements of aerospace Industry.*
    - *Since the information required to actuate and control slides was coded numerically, this technology came to be known as numerical control.*
    - *Early numerically controlled machines were fully hardwired machines as the entire control logic was implemented in hardware.*

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## Computer-Aided Manufacturing (CAM)

- Manufacturing automation primitives
  - Principle operation of a CNC machine



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## Computer-Aided Manufacturing (CAM)

- Manufacturing automation primitives
  - Principle operation of a CNC machine
    - For carrying out an operation like end milling the spindle head is to be positioned in Z- axis and the table in X and Y coordinate axes.
    - The feed movement is to be realized by the individual or simultaneous movement of X and Y axes.
    - The milling machine requires three slide movements, which are usually referred as axes feed drives.
    - A special feature of a CNC machine is that a separate motor called a servomotor individually drives each axis.

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## Computer-Aided Manufacturing (CAM)

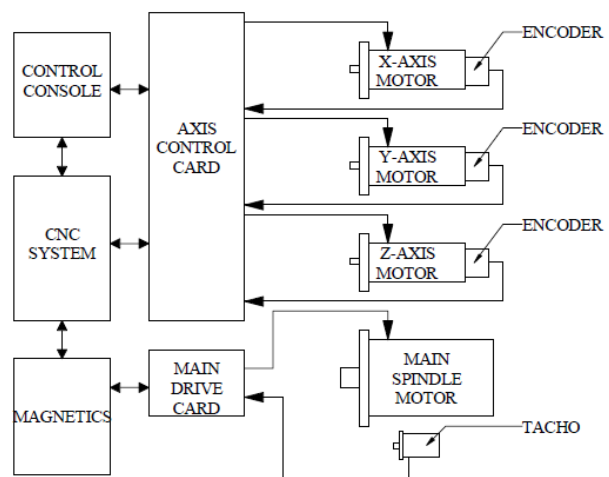
- *Manufacturing automation primitives*
  - *Principle operation of a CNC machine*
    - *In order to carry out the milling operation on the work piece the coordinate information (X, and Y coordinates) of the starting point and the ending point has to be coded in the NC program.*
    - *Similarly, the information regarding the direction of rotation and speed of the spindle, use of coolant, and the feed rate is also coded suitably.*
    - *The CNC controller decodes the positioning information coded in the NC program and the slide is moved to the programmed position at the required feed rate.*
    - *The feedback transducer is mounted either on the slide or on the servomotor and measures the displacement or position of the slide.*

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## Computer-Aided Manufacturing (CAM)

- *Manufacturing automation primitives*
  - *Principle operation of a CNC machine*

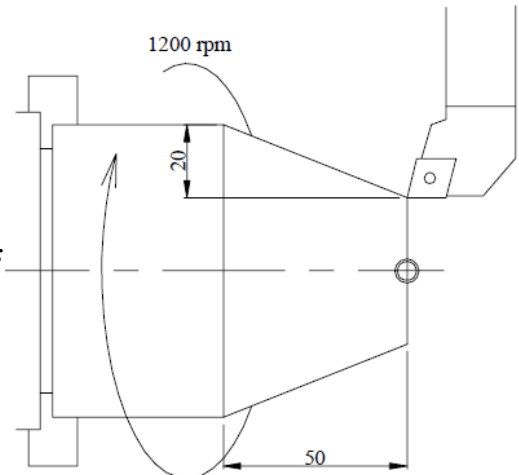


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## Computer-Aided Manufacturing (CAM)

- *Manufacturing automation primitives*
  - *Coding of information in NC machines*
    - *NC is control by information contained in a part program, which is a set of coded instructions given as numbers for the automatic control of a machine in a pre-determined sequence.*
    - ***N005 G01 U20 W-50 S1200 F0.2 M08;***



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## Computer-Aided Manufacturing (CAM)

- *Manufacturing automation primitives*
  - *Types of CNC machines*
    - *Computer numerical control is applied to a variety of machines:*
      - *Machining Centre*
        - *Horizontal*
        - *Vertical*
        - *Universal*
      - *CNC Lathes*
        - *CNC Turning Centers*
      - *Gear Hobbing Machines*
        - *Gear Shaping Machines*

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## Computer-Aided Manufacturing (CAM)

### Manufacturing automation primitives

#### Direct Numerical Control (DNC)

- Early NC machines used a tape reader for storing and inputting the program into the memory of the NC machine tool.
- The advent of CNC in mid-60's opened up the possibility of improving the performance of NC machines by interfacing them with minicomputers.
- DNC significant advantages:
  - In many cases a single computer can manage all the machines on a shop floor.
  - Programs in full or in segments can be transferred to the NC machines in a multiplexing mode.
  - The computer can be conveniently used for program editing.
  - Since the computer has large memories there is no limitation on the number or size of programs stored.
  - The computer can be used for other tasks like program creation using computer aided part program generation software as well as for operation management tasks like production planning, scheduling etc.

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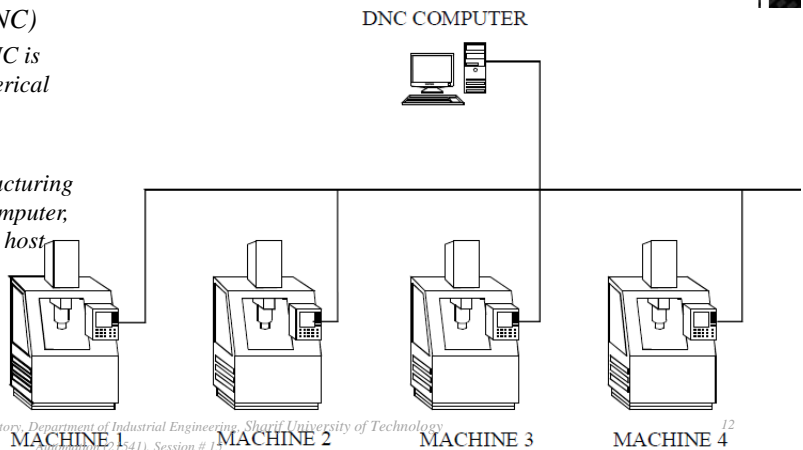
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## Computer-Aided Manufacturing (CAM)

### Manufacturing automation primitives

#### Direct Numerical Control (DNC)

- Sometimes the abbreviation DNC is used to denote distributed numerical control.
- A computer network for manufacturing may consist of a main frame computer, CAD/CAM work stations, DNC host computer and the CNC systems connected to it.



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## *Computer-Aided Manufacturing (CAM)*

- *Functions available in a typical CNC system*
  - *The functions available in a popular CNC system:*
    - *Controlled axes 2, 3, 4, 5 etc.*
    - *Simultaneous axes 2, 3, 4, 5 etc.*
    - *Max. programmable dimensions*
    - *Linear Interpolation*
    - *Multi-quadrant circular Interpolation*
    - *Thread cutting*
    - *Rapid traverse*
    - *S, T, M codes*