SUBJECT: CNC TECHNOLOGY   **SEMESTER: IV**

"Introductionto CNC"

Part - A

A. Fill in the blanks with appropriate words: (1 Mark Each)

1. CNC stands for _____.

2. NC stands **for** _____.

3. _____ can be defined as a form of programmable automation on which the process is controlled by numbers, letters & symbols.

4. The numbers, letters & symbol gathered together & logically organized to direct a machine tool for a specific job are called an _____.

5. In CNC machine, all the numerical functions are controlled by the _____.

6. In CNC machine, the part program is fed to the control unit through _____.

7. The _____ gives the command to the servo unit which drives the motors.

8. A machine tool that is capable of performing several operations under the control of part program is called_____.

9. The _____feedback is used to control the speed of the motor.

10. The _____ feedback is used to monitor the position of the slide or table.

11. In DNC system, numbers of CNC machines are connected to the _____ computer.

12. Feed back control System are _____.

13. _____is multifunctional CNC machine which is capable of performing multiple operations like milling, drilling, reaming in a sequence.

14. The tool magazine houses _____ tools.

15. A machine tool that is capable of performing several machining operations on a work part in one setup under the control of a part program is called _____.

16. An_____ table is used to orient the different positions in order to machine all the surface of the work.

17. _____will facilitate the loading of the components, unloading of the finished components.

18. In addition to xyz axis, the machining can be done in other axes also, by rotating or tilting the table so that any surface of the work can be machined in _____ machine.

19. _____ can be used to perform the different operation in a sequence.

20. A _____ sensor is incorporated in the tool magazine in order to check the location of the tool in relation to the work.

Answers:

A. Fill in the blanks

Q.No.	Answers:	Q.No.	Answers:
1	Computerised numerical control	11	host
2	Numerical control	12	positional feedback & velocity feedback
3	Numerical control	13	CNC centres
4	NC program	14	16-100
5	computer	15	CNC machining center
6	Keyboard or magnetic tape or CD	16	indexing rotary
7	control unit	17	Pallets
8	Computerised numerical control	18	CNC
9	velocity	19	Multi spindle heads
10	positional	20	probe

B. Multiple choice questions: (1 Mark Each)

1. **The accuracy of the job depends mainly on the skill of the _____.**

   a. Worker

   b. Machine

   c. Material

   d. All of the above

2. **_____means directing, guiding or retaining power over something by the use of the numbers**

   a.Numerical control

   b. Automatic control

   c.Pneumatic control

   d.Hydraulic control

3. **The numbers, letters & symbol gathered together & logically organized to direct a machine tool for a specific job are called an**

   a. NC program.

   b. Conventional program

   c. CNC program

   d. All of the above

4. **The numerical functions are controlled by the computer is called_____**

   a. NC machine

   b. Conventional machine

   c. CNC machine

   d. Hydraulic machine

5. **The _____ feedback is used to control the speed of the motor.**

a. Velocity   b. Positional

c. Vector   d. None of the above

6. **The positional feedback is used to monitor the position of the slide or table.**

a. Velocity   b. Positional

c.Vector   d. None of the above

7. **It is multifunctional CNC machine which is capable of performing multiple operations like milling, drilling, reaming in a sequence**

a.CNC centres   b.CNC machining centre

c. CNC milling centre   d.CNC turning centre

8. **The tool magazine houses _____ number of tools.**

a. 16-40   b. 16-60

c. 16-80   d. 16-100

9. **_____ is to pick the tool, which is programmed and fix it to the machine spindle.**

a.Automatic tool changer   b.Pallet shuttle

c.Tool magazine   d.Tool drum

10. **According to the position of the axis of the spindle the CNC centers are classified as**

a.Horizontal spindle machining centre.   b.Vertical spindle machining centre.

c. Universal machining centre.   d.All of the above

11. **CNC machines is called as:**

a. Universal machine   b. Conventional machine

c.Automatic machine   d.None of the above.

12. **According to the type of CNC centre**

a. CNC turning centre   b. CNC milling centre

c.CNC grinding centre   d. All of the above

13. A machine tool that is capable of performing several machining operations on a work part in one setup under the control of a part program.

    a.CNC turning centre   b.CNC milling centre

    c.CNC grinding centre   d. CNC machining centre

14. An _____ table is used to orient the different positions in order to machine all the surface of the work

    a. Indexing rotary   b.Magazine

    c.Tool drum   d.Pallet shuttle

15. _____facilitate the loading of the components, unloading of the finished components

    a.Indexing rotary   b. Magazine

    c.Tool drum   d.Pallet shuttle

16. _____ heads can be used to perform the different operation in a sequence drilling and reaming

    a. Universal heads   b. Spindle heads

    c. Tilting heads   d.Multiple spindle heads

17. A probe sensor is incorporated in the tool magazine in order to check the location of the tool in relation to the work

    a. Probe sensor   b.Touch sensor

    c. Proximity sensor   d. All of the above

18. Which of the following is related to FMS?

    a. Material Handling System   b. Auxiliary equipment

    c. Central Computers   d.All of the above

19. A machine tool that is capable of performing all machining operations on a cylindrical work part in one set of under the control of part program.

    a. CNC turning center   b.CNC milling center

    c.CNC grinding center   d.None of the above

20. Loading and Unloading of components_____ are used.

    a.Pallet shuttle   b.Conveyor

c.Spindle   d.Computer

Answers:

B. Multiple choice questions

Q.No.	Answers	Q.No.	Answers
1	a. Worker	11	a.Universal machine
2	a.Numerical control	12	d.All of the above
3	a. NC program.	13	d.CNC machining centre
4	c. CNC machine	14	a. Indexing rotary
5	a. Velocity	15	d. Pallet shuttle
6	b. Positional	16	d. Multiple spindle heads
7	a. CNC centres	17	a.Probe sensor
8	d. 16-100	18	d. All of the above
9	a. Automatic tool changer	19	a.CNC turning center
10	d. All of the above	20	a.Pallet shuttle

C. Answer the following questions: (2 Marks Each)

1. **Define CNC.**

   Ans: InCNC machine, all the numerical functions are controlled by the computer. The computer also stores the programs which are required to run the machine. The computer also gives the display of various parameters of the machines like spindle speed, feed rate etc.

2. **Define Numerical control.**

   Ans: Numerical control can be defined as a form of programmable automation on which the process is controlled by numbers, letters & symbols.

3. **What is NC program?**

   Ans: The numbers, letters & symbol gathered together & logically organized to direct a machine tool for a specific job are called an NC program.

4. **What are the types of feedback devices?**

   Ans: There are two feedback devices they are

   a. velocity feedback &

   b. positional feedback.

5. **What is the use of velocity feedback?**

   Ans: The velocity feedback is used to control the speed of the motor.

6. **What is the use of positional feedback?**

Ans: The positional feedback is used to monitor the position of the slide or table.

7. **What is the main advantage of CNC machine?**

Ans: The main advantage of CNC machine is it eliminates human errors.

8. **What is the disadvantage of CNC machine?**

Ans: The disadvantage of CNC machine is its initial cost is high.

9. **What is CNCcenter?**

Ans: It is multifunctional CNC machine which is capable of performing multiple operations like milling, drilling, reaming in a sequence. A CNC centre will incorporate two basic elements.

10. **What are the basic elements of CNC centre?**

Ans: The basic elements of CNC centre are

   a. Indexable tool magazine or tool Drum.
   b. Automatic Tool Changer(ATC)

11. **What are the two basic elements of CNCcentre?**

Ans: A CNC centre will incorporate two basic elements. They are;

   a. Indexable tool magazine or tool Drum.
   b. Automatic Tool Changer (ATC)

12. **What is the function of Automatic tool changer?**

Ans: The function of the ATC is to pick the tool which is programmed and fix it to the machine spindle.

13. **What are the advantages of CNC centres?**

Ans: The advantages of CNC centers are

   a. Higher flexibility
   b. Increased production

14. **What do you mean by CNC machining center?**

Ans: A machine tool that is capable of performing several machining operations on a work part in one setup under the control of a part program.

15. **What is the function of Automatic tool changer?**

Ans: As the machine centre performs different operations, it requires different tools. These tools arranged in a tool magazine or tool drum. When the tool is head is to be changed,the tool drum is rotated through a desired angle to feed the tool.

16. **What is the function of indexing rotary table?**

Ans: An indexing rotary table is used to orient the different positions in order to machine all the surface of the work.

17. **Why we are using pallet shuttle in CNC?**

    Ans: This will facilitate the loading of the components, unloading of the finished components while machining is progressing on the one of the pallets.

18. **Which feature is used to orient the different positions in order to machine all the surface of the work?**

    Ans: An indexing rotary table is used to orient the different positions in order to machine all the surface of the work.

19. **What is the function of Probe sensor?**

    Ans: A probe sensor is incorporated in the tool magazine in order to check the location of the tool in relation to the work.

20. **What are the different methods of tool monitoring system?**

    Ans:
    1) Direct tool monitoring:
    2) Indirect tool monitoring

Part – B

I. Answer the following questions: (3 Marks Each)

1. **What are the disadvantages of conventional machines?**

   Ans:
   i.   more time consumption
   ii. less accuracy
   iii. less production
   iv. require skilled labours
   v.   more wastage of materials

2. **Write the classification of CNC centres.**

   Ans: CLASSIFICATIONS OF CNC CENTERS:

   1. According to the position of the axis of the spindle.

      a) Horizontal spindle machining centre.

      b) Vertical spindle machining centre.

      c) Universal machining centre.

   2. According to the type of CNC centre.

      a) CNC turning centre

      b) CNC milling centre

      c) CNC grinding centre

3. **Define CNC turning center.**

   Ans: A machine tool that is capable of performing all machining operation on a cylindrical work part in one setup under the control of part program.'' A turning centre one where more

number of operations is performed once the job is set. It consists of a power-driven tool, turret that holds 6- 18 tools to perform different jobs.

4. **What are the disadvantages of CNC machine?**

   Ans: The Disadvantages of CNC:
   1. Initial cost is high.
   2. It requires skilled programmers.
   3. It is not suitable for small-scale production.
   4. Maintenances cost is more.

5. **Define CNC milling center**.

   Ans: ''A machine tool that is capable of performing several machining operations on a work part in one setup under the control of a part program.'' It reduced number of setups, setup time, transportation of job, waiting time of machine etc.

II. Answer the following questions: (5 Marks Each)

1. **What are the advantages of CNC machine?**

   Ans: Advantages of CNC machine:
   1. It eliminates human errors.
   2. Requires semi-skilled labours.
   3. Higher flexibility
   4. High accuracy.
   5. Wastage is minimum.
   6. Suitable for batch productions.
   7. Reduces inspection cost.
   8. More operational safety.
   9. Quality of product is high.
   10. Greater utilization of labor.
   11. Safety of machine tool.
   12. Less rejection.
   13. Increased productivity.
   14. Reduce non-productive time.

2. **Write a note on advanced manufacturing system.**

   Ans: While the various revolution stages in the development of CNC machines provided the means for efficient part production, over a period of time and with a rapid development in

electronic, the machine tool technology granted from the concept of standalone machine tool to system-oriented manufacture. This result in the introduction of flexible manufacturing cell (FMC); flexible manufacturing system and computer integrated manufacturing (CIM). Thus, embassy as stiffed from mechanical hardware in case in case of conventional, electronic & software which now accounts for 30-50% of the value of modern manufacturing system.

3. **Write the applications of CNC machine.**

   Ans: The applications of CNC:
   1. Number of operations per component are many
   2. Complexity of the operations
   3. Size of batches is medium
   4. Repetitions of batches is large
   5. Layout costs of the component is high
   6. Variety of components to be produced is more
   7. Cost of special tooling involved is high
   8. Design changes are frequent
   9. Number of dimensions in a component is more
   10. Precision required in a component
   11. Uniform cutting condition.

4. **What are the advantages of CNC centers?**

   Ans: The advantages of CNC centres are:
   1. Higher flexibility
   2. Increased production
   3. Consistent quality
   4. Reduced scrap rate
   5. Reliable operation
   6. Reduced non-productive time
   7. Reduced labor
   8. Shorter cycle time
   9. Higher accuracy
   10. Reduced lead-time
   11. Just in time (JIT) manufacturing
   12. Automated material handling
   13. Lesser floor space

5. **What are the characteristics of Flexible manufacturing system?**

   Ans: The characteristics feature of FMS is as following:

a. Solve the production problem of mid volume and mid Varity parts for which neither the high production rate transfer lines nor the highly flexible standalone CNC machine is suitable.

b. Designed to process simultaneously, several types of parts in defined mix.

c. Equipped with sophisticated flexible machine tool, which are capable for processing a sequence of different parts negligible tool change over time.

d. Parts are transferred machine to machine by a computer-controlled material handling system
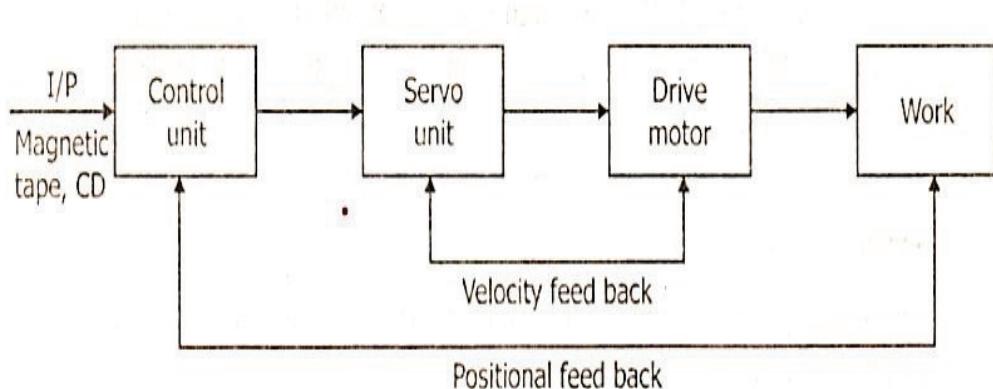
6. **What are the benefits of FMS?**

Ans: The benefits of FMS are:
a. Flexibility to change part variety
b. Higher productivity
c. Higher machine utilization
d. Balanced output
e. Less rejection
f. High product quality
g. Reduced work in process and inventory
h. Better control over production
i. Just in time manufacture (JIT)
j. Minimally manned operation
k. Easies to expand

III. Answer the following questions: (8 Marks Each)

1. **With a neat block diagram, explain CNC machine.**

Ans: BLOCK DIAGRAM OF CNC MACHINE:

i. The part program is fed to the control unit through key board or magnetic tape or CD.

ii. Based on the part program, the control unit gives the command to the servo unit, which drives the motors. The motor intern drives the spindle and the table.

iii. There are two feedback devices they are velocity feedback & positional feedback.

iv. The velocity feedback is used to control the speed of the motor.

v. The positional feedback is used to monitor the position of the slide or table.

2. **Write the difference between NC machine tool and CNC machine tool.**

Ans: The differences are as follow:

NC Machine Tool	CNC Machine tool
1. NC Controller unit is hard wired	1. CNC Controller unit is based on a microcomputer.
2. Punched tape only can be used as input medium.	2. Punched tape, magnetic tape, floppy disk, compact disk, pen drive and manual data input are used as input medium
3. The part program prepared using tape must be read each time when the work piece in the batch is to be produced.	3. The part program is read only once and stored in the computer memory. It can be retrieved while producing every work piece in the batch.
4. The punched tape and tape reader are least reliable	4. The computer memory is more reliable
5. Conversion of units is not possible.	5. Automatic conversion of units is possible
6. The part program cannot be edited at the machine site	6. The part program can be edited and optimized at the machine site itself
7. Machine cycles and sub-routines are not available	7. The frequently used machine cycles and sub-routines are stored as macros and can be called by the part program when required
8. Only linear and circular interpolations can be executed	8. Linear, circular, helical, parabolic and cubic interpolations can be executed
9. Compensation for any change in dimension of the cutting tool is not possible	9. It allows compensation for changes in the dimensions of the cutting tool
10. Simulation of part program is not possible	10. Simulation of part program is possible
11. The information on machine utilization cannot be obtained	11. The information on machine utilization can be obtained
12. It is not possible to make changes in feeds and speeds during the cutting process	12. It is possible to make changes in feeds and speeds during the cutting process
13. NC system has no diagnostic capabilities	13. CNC system has on-line diagnostics capability to detect malfunction or to diagnose system breakdown.

3. **Explain the additional features of CNC machining center.**

Ans: Additional features of CNC machining centres:

1. **Automatic tool changing:**

   As the machine centre performs different operations, it requires different tools. These tools arranged in a tool magazine or tool drum. When the tool is head is to be changed, the tool drum is rotated through a desired angle to feed the tool.

2. **Automatic work positioning:**

An indexing rotary table is used to orient the different positions in order to machine all the surface of the work.

3. **Pallet-shuttle:**

The CNC machine are fitted with 2 or more pallets, this will facilitate the loading of the components, unloading of the finished components while machining is progressing on the one of the pallets. This eliminates the idle time in loading and unloading.

4. **Multi axes machining:**

In addition to xyz axis, the machining can be done in other axes also, by rotating or tilting the table so that any surface of the work can be machined.

5. **Multi – spindle head:**

Multi spindle heads can be used to perform the different operation in a sequence. E.g.; drilling and reaming.

6. **In process gauging:**

A probe sensor is incorporated in the tool magazine in order to check the location of the tool in relation to the work. This is a feedback to the actuator. If there are any errors in the setting, the actuator will reset the tool.

4. **Write the step-by-step development of CNC milling center.**

Ans: STEP BY STEP, DEVELOPMENT OF CNC MILLING CENTRES:

1. A vertical machining centre (VMC) with three axes for multiple machining operations, with manual tool changing and loading of the job.

2. A vertical machine centre is fitted with an index able head that acts as tool turret for automatic tool changing (ATC)

3. Addition of a tool magazine to accommodate more tools with an automatic tool changing

4. Introduction of horizontal machining centre with an ATC came into existence.

5. Introduction of rotary indexing table for multi-axes machining.

6. Addition of two or more pallets to eliminate the idle time during loading & unloading.

7. Introduction of tool life monitoring system to prevent the breakage & for replacement of the tool.

8. Increasing the capacity of the tool magazine.

9. Introduction of DNC programming (direct numerical control) for loading & unloading

10. Increasing the spindle speed for high rate of metal removal.

11. Increasing the speed of the table.

12. Improved thermal control for better accuracy of the job.

5. **Write the step-by-step development of CNC turning center.**

    Ans:STEP BY STEP DEVELOPMENT OF CNC TURNING CENTRE:

    1. Install CNC turning machine which 2 axes machining & indexing tool turret with horizontal bed for basic operations.

    2. Introduce slant belt configuration for higher rigidity & easy loading & unloading.

    3. Introduce disc type tool turret for a greater number of tools.

    4. Multi operational machining with addition of more axes.

    5. Add sub spindle foe side turning operation.

    6. Introduction of drum type tool magazine.

    7. Addition of milling head.

    8. Introduction of tool monitoring system.

    9. Introduction of sensors system for spindle bearings to detect forced vibrations and abnormal tool conditions.

    10. Introduction of higher spindle speed, rapid traverse rates, fastest turret indexing for better productivity.

    11. Introduction of automatic coolant system for cooling the tool & the job & to remove the chips.

    12. Introduce servo control spindle drive for better operation.

6. **Explain tool-monitoring system.**

    Ans: Tool monitoring system: During machining operation, the tool wears out resulting in low quality product damage of work & accuracy. It is important to monitoring the tool wear and tool breakage properly it could be done in 2ways

    1) Direct tool monitoring: Condition of tool is monitored by touch probe, tool edge condition, tool angle and position of the tool. All these information passes to the control system, to compete any variations occurs in a dimension.

    2) Indirect tool monitoring: In this condition of the tool are chucks by monitoring certain parameters, which are, reflect the condition of tools, as follows:

    a) Vibrations

    b) Power consumption

    c) Magnitude of the cutting force

    d) Heat generations

    e) Quality or dimension of work.

    Therefore, all advanced CNC machine is equipped with in direct monitoring system.

Chapter No: 02

"Components of Numerical Controle System"

Part – A

A. Fill in the blanks with appropriate words: (1 Mark Each)

1. Computer numerical control system consists of _____basic components.
2. The part program is written in_____form.
3. The part program is fed to the_____ unit.
4. In numerical control,_____ means off and _____ means on.
5. In numerically controlled, machine all the movements of the _____ and _____ table.
6. The tool changing is done by _____.
7. _____is used for controlling the speed and feed.
8. The actual system used in _____control is the BCD system.
9. ISO stands for _____.
10. EIA stands for _____

Answers:

A. Fill in the blanks

Q.No.	Answers:	Q.No.	Answers:
1	Three	6	Automatically.
2	Coded	7	Motor
3	MCQ	8	numerical
4	Zero , One	9	International standard organization.
5	Tool , Machine	10	Electronic industries association.

B. Multiple choice questions: (1 Mark Each)

1. In addition the speed of the spindle motor is controlled by

a.Program   b. Part program

c. NC drive   d.DNC

2. The motor is used for controlling the

a.Speed and Feed   b.Table

c) Spindle   d. Guide way

3. The machine may have a tool magazine that tool changing is by

a.Manual   b.Machine

c. Automatically   d.None of these

4. Decimal data input to control system is

    a.0 to 10   b.10 to 1

    c.1 to 9   d.1 to 10

5. Binary equipment data input to control system is

    a.0 to 1010   b.1 to 1010

    c.10 to 1000   d.0 to1001

6. The computer numerical control system consists of basic components

    a.5   b.4

    c.3   d.10

7. The part programmed is written in

    a. Preparatory function   b.Coded form

    c.NC form   d. None of the above

8. The MCU generally consists of

    a.CPM   b.CPU

    c.Motor   d.DNC

9. The unit for cutting speed is

    a.Mm/min   b.Tooth/min

    c.Mts/min   d.Mm/rev

10. The most commonly used coding system

    a. ISO   b. MCQ

    c.EIA   d.None of above

Answers:

B. Multiple choice questions

Q.No.	Answers:	Q.No.	Answers:
1	b. Part program	6	c. 3
2	a. Speed and Feed	7	b. Coded form
3	c. Automatically	8	b. CPU
4	a. 0 to 10	9	a. Mm/min
5	a. 0 to 1010	10	a. ISO

C. Answer the following questions: (2 Marks Each)

1. What are the three control systems?

Ans:A computer numericalcontrol (CNC) system consists of three basic components: CNC software that is a program of instructions, a machine control unit, and processing equipment, also called machine tool.

2. List out basic components?

Ans: Five basic components of computer system

1. Input Unit.
2. Output Unit.
3. Storage Unit.
4. Central Processing Unit (CPU)
5. Arithmetic and Logic Unit (ALU)
6. Control Unit.

3. How speed and feed controlled?

Ans: Feed Rate is one of the most important factors to consider when implementing any CNC strategy. Simply put, feed rate is the speed at which the cutter engages the part and is typically measured in units/minute. In addition, many other cutting factors including desired surface and the characteristics of the CNC machine itself.

4. Write Binary and Decimal code?

Ans: Truth Table for Binary Coded Decimal

Decimal Number	BCD 8421 Code
3	0000 0011
4	0000 0100
5	0000 0101
6	0000 0110

5. What is programming?

Ans:CNC programming software creates program codes and instructions used to run a machine tool controlled by a computer. ... In general terms, CNC stands for Computer Numerical Control and has been around since the early 1970's (often referred to as NC programming).

6. What is the difference between NC and CNC?

Ans: Difference between NC and CNC Machine. CNC and NC are both automatic machines used for machining any metal with accurate dimensions. ... In the NC machine, programs are fed into the punch cards. In a CNC machine, the programs are fed directly into the computer using a small keyboard.

7. Define NC and DNC?

Ans:NC denotes a computer numerical control system, a mode of automation of machine tools that uses a dedicated microprocessor or computer to execute preprogrammed sequence machine control commands. ... DNC (Direct Numerical control/ distributed numerical control) denotes the networking of CNC machines

8. **Define MCU?**

   Ans: The machine control unit (MCU) is the heart of a CNC system. It is used to perform the following functions: To read the coded instructions. To decode the coded instructions. To implement interpolations (linear, circular, and helical) to generate axis motion commands.

Part - B

I. Answer the following questions: (3 Marks Each)

1. **What is the meaning of coded and decoded?**

   Ans: Coding, therefore, means rule or method used to hide the actual meaning of a word or group of words and decoding means the method of making out the actual message that is disguised in coding.

2. **Explain auxiliary control function?**

   Ans: control of auxiliary functions such as spindle rotation and coolant. The program input device is the means for part program to be entered into the CNC control. System. It is used to perform the following functions: • to read the coded instructions.

3. **Explain past program?**

   Ans: The part program is a sequence of instructions, which describe the work, which has to be done on a part, in the form required by a computer under the control of computer numerical control (CNC) software. It is the task of preparing a program sheet from a drawing sheet.

4. **What is the application of NC machine?**

   Ans: the use of numerical information for the control of such machining processes is predominantly through the numerical control NC of machines. Today numerically controlled devices are used in all manner of industries. Milling machines manufacture the moulds and dies for polymer products.

5. **Explain NC coding?**

   Ans: The program of instructions is communicated to the machine tool using a coding system based on binary numbers. This NC coding system is the low-level machine language that can

be understood by the MCU. ... Conversion of the 10 digits in the decimal number system into binary numbers

II. Answer the following questions: (5 Marks Each)

1. **What are the functions of MCU?**

   Ans: The machine control unit (MCU) is the heart of a CNC system. It is used to perform the following functions:

   - To read the coded instructions.
   - To decode the coded instructions.
   - To implement interpolations (linear, circular, and helical) to generate axis motion commands.
   - To feed the axis motion commands to the amplifier circuits for driving the axis mechanisms.
   - To receive the feedback signals of position and speed for each drive axis.
   - To implement auxiliary control functions such as coolant or spindle on/off and tool change.

2. **Explain punched cards?**

   Ans: A punched card or punch card is a piece of stiff paper that can be used to contain digital data represented by the presence or absence of holes in predefined positions. ... Many early digital computers used punched cards as the primary medium for input of both computer programs and data.

3. **What are the basic components of NC machine?**

   Ans: What are the three basic components of an NC system? Answer: The three components are (1) the part program of instructions, (2) the machine control unit, and (3) theprocessing equipment (e.g., machine tool) that accomplishes the operation.

4. **Explain machine tool?**

   Ans: A machine tool is a machine for handling or machining metal or other rigid materials, usually by cutting, boring, grinding, shearing, or other forms of deformation. ... All machine tools have some means of constraining the workpiece and provide a guided movement of the parts of the machine.
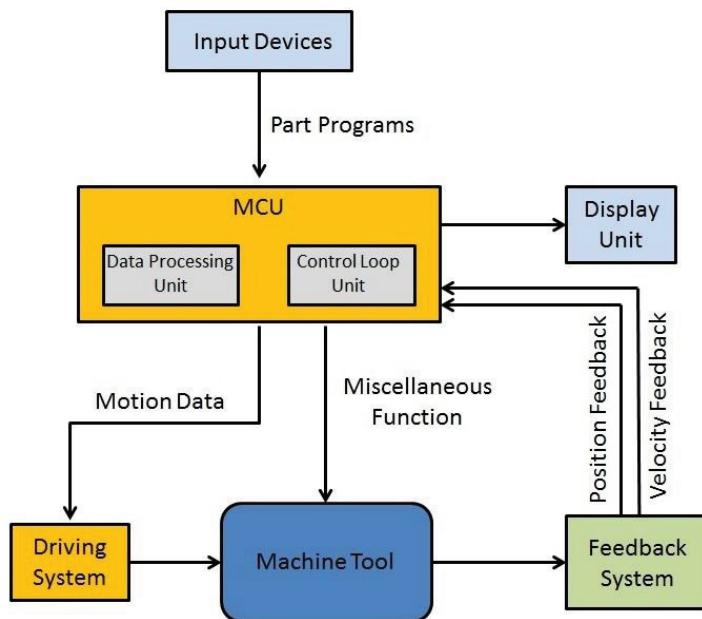
5. How CNC machine classified?

Ans: According to the functions or types of machined parts, CNC machines can be classified into five types: CNCmilling machines, CNC lathes, CNC drilling machines, CNC plasma cutters, and CNC grinders.

III. Answer the following questions: (8 Marks Each)

1. Draw neat diagram of MCU and name the parts?

Ans: Neat diagram of MCU

MCU or Machine Control Unit is the heart of a CNC system actually. ... Then, it helps to send the proper instruction to every part of the machine. It can recognize interpolations (circular, straight, and helical) to form axis transfer commands

2. What is main program and sub program? Explain in brief?

Ans: Subprograms are normal cnc programs, which are called from a program (normally called main-program) to add some kind of repeatable machining operation. You (cnc machinist/ cnc programmer) not have to learn a new G-code or programming style, all you use is the knowledge of cnc programming, which you already have.

A subprogram is a sequence of instructions whose execution is invoked from one or more remote locations in a program, with the expectation that when the subprogram execution is complete, execution resumes at the instruction after the one that invoked the subprogram.

3. **What do you understand by components of numerical control system?**

Ans: Machine tool is the main components of a numerical control system, which executes the operations. It may consist of worktable, cutting tools, jigs and fixtures, motors for driving spindle and coolant and lubricating system. The latest development in the numerical control machine tool is the versatile machining center.

Three basic components of an NC system:

  i.   Input medium: - Part program or instructions needed to drive the machine tool components.
  ii.   Machine control unit (MCU): - Electronics & control hardware.
  iii. Machine tool

4. **Explain machine tool and other equipment?**

Ans: A machine tool is a machine for handling or machining metal or other rigid materials, usually by cutting, boring, grinding, shearing, or other forms of deformation. ... All machine tools have some means of constraining the work piece and provide a guided movement of the parts of the machine.

CNC Turning: Turning is a slightly different process compared to CNC milling. CNC turning relies upon computer-controlled machines, but creates a different end product. The process uses a single-point cutting tool that is inserted parallel to the material that will be cut.

Chapter No: 03

"Classification of Numerical Control Machine"

Part - A

A. Fill in the blanks with appropriate words: (1 Mark Each)

1. Displacement Feedback loop system in CNC _____ loop used.
2. Feed back control systems are _____ & _____ .
3. _____ system is the brain of the machine.
4. _____ provides for three linear axes of movement at right angles to each other.
5. The cylindrical co-ordinate system combines both _____ and _____ movements.
6. Interpolator is present in case of _____ control system.
7. The _____ stores the preprogrammed information and controls the peripheral devices.
8. _____ Interpolation is used to machine circles and arcs.
9. In NC (Numerical Control) machine tool, the position feedback package is connected between _____ and _____ .
10. The method by which continuous path system moves from one point to another point is called _____ .

Answers:

A. Fill in the blanks

Q.No.	Answers:	Q.No.	Answers:
1	Closed)	6	Contouring
2	Open-loop & Closed loop	7	Controller
3	Control	8	Circular
4	Cartesian coordinate system	9	Control unit and Machine tool
5	Horizontal & linear	10	Interpolation

B. Multiple choice questions: (1 Mark Each)

1. **Based on _____ control, the NC/CNC systems are classified.**

   a.Sensor

   b.Feedback

   c.Machine

   d. None of the above.

2. **Classification based on control system features are,**

   a.Straight line control system

   b.Point – to – Point control system

   c.Contouring control system

   d. All of the above.

3. **The _____ system is a high technology and most versatile control system.**

   a. Straight line control system

   b.Point – to – Point control system

   c. Continuous path control system

   d. None of the above

4. **In cylindrical co-ordinate system,**

   a.2 rotational and 1 linear movement

   b.2 linear and 1 rotational movement

   c.3 linear movement

   d.All rotational movement.

5. **The _____ stores the preprogrammed information and controls the peripheral devices.**

   a.Control system.

   b.Controller.

   c.Sensors.

   d.End effectors.

6. **The device, fed to the control unit of NC machine tool, which sends the position command signals to sideway transmission elements of the machine, is called as _____.**

   a. Controller

   b.**Tape**

   c. Feedback unit

   d.None of the above

7. **In NC (Numerical Control) machine tool, the position feedback package is connected between _____ and _____.**

   a. Control unit and programmer

   b. Programmer and machine tool

   c. Control unit and machine tool

   d. Programmer and process planning

8. **The machine tool, in which calculation and setting of the operating conditions like depth of cut, feed, and speed are done during the machining by the control system itself, is called _____.**

   a. Computer Numerical Control System

   b.Direct Numerical Control System

   c.Machining Centre System

   d.Adaptive Control System

9. **A CNC milling machine would have _____.**

   a. Point to point open loop control only

   b.Point to point closed loop control only

   c. Countering control

   d.None of the above

10. **In a point-to-point feed axis employing a stepper motor as a prime mover _____.**

    a. An encoder for position feedback is a must

    b.An interpolator is a must

    c. A tachogenerator is a must

    d.None of the above

Answers:

B. Multiple choice questions

Q.No.	Answers:	Q.No.	Answers:
1	b. Feedback	6	b.**Tape**
2	d.All of the above.	7	**c. Control unit and machine tool**
3	c. Continuous path control system	8	**d.Adaptive Control System**
4	b.2 linear and 1 rotational movement	9	**c. Countering control**
5	b.Controller.	10	d.**None of the above**

C. Answer the following questions: (2 Marks Each)

1. **How CNC/NC machines are classified?**

   Ans:
   - Based on feedback control
   - Based on control system features

2. **Based on feedback control, How NC/CNC systems are classified.**

   Ans:
   - Open loop control system
   - Closed loop control system

3. **Mention the classification based on control system features.**

   Ans:
   - Point to point control system
   - Straight line control system
   - Continuous path control system

4. **Name the Two types of feedback required in closed loop control system?**

   Ans:
   - Velocity feedback

- Positional feedback

5. **Name the Two types of co-ordinate system?**

   Ans:
   - Cartesian coordinate system
   - Cylindrical coordinate system

6. **Name the two-position feedback measuring devices?**

   Ans:
   - Rotary or angular position measuring transducers
   - Linear position measuring transducers

7. **Name the three types of interpolation?**

   Ans:
   - Linear
   - Circular
   - Parabolic

8. **Why Velocity feedback is used?**

   Ans: Velocity feedback is used to measure and monitor the speed of the drive motor.

9. **Why circular interpolation is used?**

   Ans: Circular interpolation is used to machine circles and arcs.

10. **Why Positional feedback is used?**

   Ans: Positional feedback is used to measure and monitor the position or displacement of the machine slides.

Part - B

I. Answer the following questions: (3 Marks Each)

1. **Define Open-loop control system?**

   Ans: Machine tool controls in which there is no provision to compare the actual position of the cutting tool or work piece with the input command value are called open loop systems.

2. **Define Close-loop control system?**

Ans: In a closed loop control system the actual output from the system i.e, actual displacement of the machine slide, is compared with the input signal. The closed loop control systems are characterized by the presence of feedback devices in the system.

3. **Define Point-to-Point control system?**

   Ans: Point to point control is one where accurate positional control is required only to place the machine slides in fixed position and the machine tool slide is required to reach a particular fixed coordinate point in the shortest possible time.

4. **Define Straight-line control system?**

   Ans: Straight line or straight cut CNC system is an extension of point to point control system with the provision of machining along a straight line as in case of milling and turning operations.

5. **Define Contouring control system?**

   Ans: The contouring system is a high technology and most versatile control systems. The contouring system generates a continuously controlled motion of the tool and work piece along different coordinate axis.

6. **Define Circular interpolation?**

   Ans: In circular interpolation the current point acts as the starting point for the circular interpolation and the programmer has to specify end point of the arc and the radius of the arc.

7. **Define Cartesian coordinate system?**

   Ans: The Cartesian configuration provides for three linear axes of movement at right angles to each other. The modes of movement are similar to those of a milling machine, providing movement in X, Y and Z-axes.

8. **Define cylindrical coordinate system?**

   Ans: The cylindrical configuration combines both vertical and horizontal linear movement, with rotary movement in the horizontal plane about the vertical axis. It is so called because its motions sweep out a cylindrical working volume.

9. **Define linear interpolation?**

   Ans: Linear interpolation means moving from one programmed point to another programmed point in straight line.

10. **What is Interpolation?**

   Ans: The method by which continuous path system moves from one point to another point is called Interpolation.

II. Answer the following questions: (5 Marks Each)

1. **Write the difference between open loop control system and closed loop control system?**

   Ans:

Open Loop Control Systems	Closed Loop Control Systems
• Control action is independent of the desired output.	• Control action is dependent of the desired output.
• Feedback path is not present.	• Feedback path is present.
• These are also called as non-feedback control systems.	• These are also called as feedback control systems.
• Easy to design.	• Difficult to design.
• These are economical.	• These are costlier.
• Inaccurate.	• Accurate.

2. **Explain Velocity feedback?**

   Ans: Velocity feedback is normally provided by a device called Tachogenerator. A tachogenerator is simply a voltage generator that gives voltage output, which is proportional to its speed. The tachogenerator is normally built in the servomotor case and is directly fitted on the servomotor shaft. The output voltage from the tachogenerator is used as feedback to monitor the motor speed. Rotary encoders are also used to provide feedback for velocity control.

3. **Explain Position feedback?**

   Ans: The ideal methods of measuring the displacement or position of the cutting tool will be to continuously measure the position of the cutting tool edge relative to the datum point. This will result in accurate displacements and it will take into account the tool wear, etc. but measurements from cutting edge are not possible due to the presence of chips, coolants, holding devices and in some cases, due to the component geometry itself.

4. **Explain point-to-point control system?**

   Ans: Point to point control is one where accurate positional control is required only to place the machine slides in fixed position and the machine tool slide is required to reach a particular fixed coordinate point in the shortest possible time. Point to point system is suitable for drilling, boring, tapping, punch presses and jig boring machines.

5. **Explain straight-line control system?**

   Ans: Straight line or straight cut CNC system is an extension of point to point control system with the provision of machining along a straight line as in case of milling and turning operations. This is obtained by providing movement at controlled feed rate along the axis in the line of motion. It is possible to machine along diagonal lines with movement in two axis at a controlled feed rate.

6. **Explain continuous path control system?**

   Ans: The contouring system is a high technology and most versatile control systems. The contouring system generates a continuously controlled motion of the tool and work piece along different coordinate axis. This control system enables the machining of profiles, contours and curved surface. A system designed for continuous path machining can, of course, be used for point-to-point and straight line machining but that will result in under utilization of the system.

7. **Explain Cartesian coordinate system?**

   Ans: The Cartesian configuration provides for three linear axes of movement at right angles to each other. The modes of movement are similar to those of a milling machine, providing movement in X, Y and Z-axes. It may also be termed a rectangular configuration since its working range sweeps out a three dimensional rectangular volume.

8. **Explain with rough sketch cylindrical co-ordinate system?**

   Ans: The cylindrical configuration combines both vertical and horizontal linear movement, with rotary movement in the horizontal plane about the vertical axis. It is so called because its motions sweep out a partially cylindrical working volume. This robot configuration finds application finds application in radial work piece layouts where the work is approached primarily in the horizontal plane and where no obstructions are present.

9. **Write the advantages of Cartesian coordinate systems?**

   Ans:

   - High accuracy
   - Control system simplicity
   - Inherently stiff structure
   - Large area coverage
   - Large payload capacity

10. **Write the advantages of cylindrical co-ordinate system?**
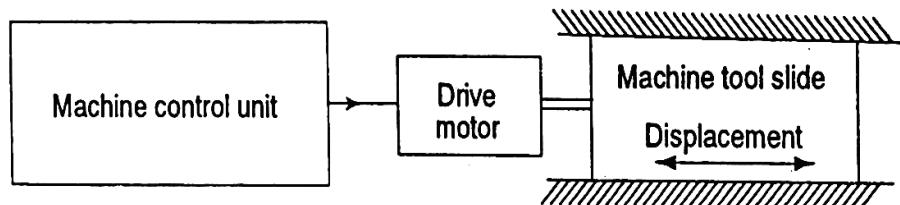
    Ans:

    - Easily controlled/programmed movements
    - Control system simplicity
    - Good accuracy
    - Fast operation
    - Good access to front and sides

III. Answer the following questions: (8 Marks Each)

1. **Explain open loop CNC system with diagram?**
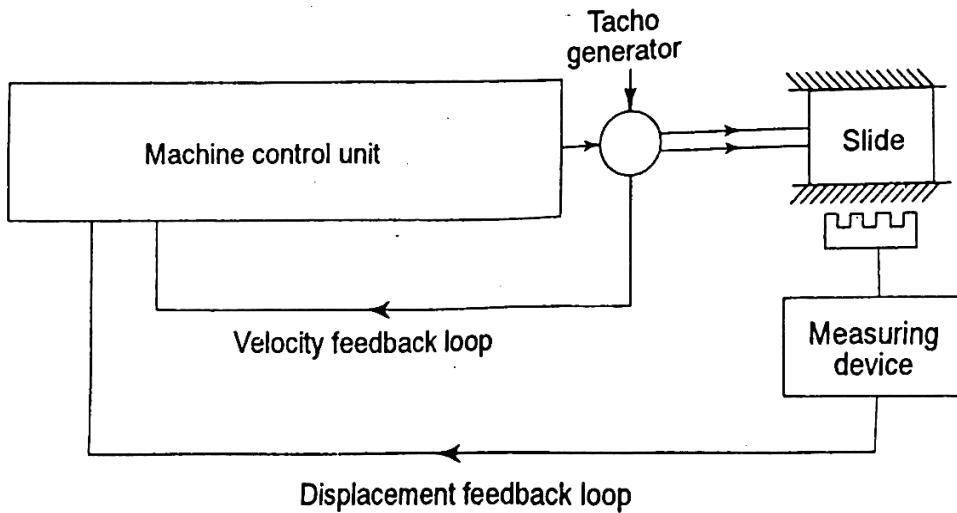
   Ans: Machine tool controls in which there is no provision to compare the actual position of the cutting tool or work piece with the input command value are called open loop systems. Fig shows the block diagram of an open loop control system.

   Fig. 3.1. *Block diagram of an open-loop system*

2. **Explain closed loop CNC system with diagram?**

   Ans: In a closed loop control system the actual output from the system i.e, actual displacement of the machine slide, is compared with the input signal. The closed loop control systems are characterized by the presence of feedback devices in the system. Fig shows the block diagram of a closed loop control system.

Fig. 3.2. *Block diagram of a closed-loop system*
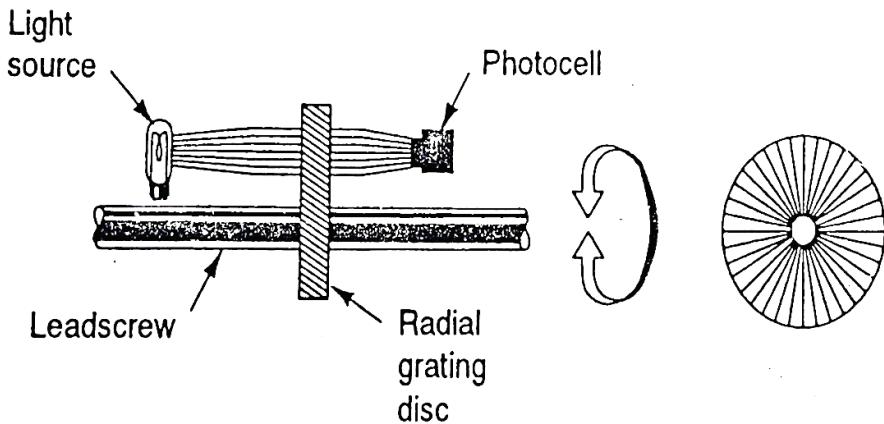
3. **Mention the difference between open loop control systems and closed loop control systems?**

   Ans:

Open Loop Control Systems	Closed Loop Control Systems
• Control action is independent of the desired output.	• Control action is dependent of the desired output.
• Feedback path is not present.	• Feedback path is present.
• These are also called as non-feedback control systems.	• These are also called as feedback control systems.
• Easy to design.	• Difficult to design.
• These are economical.	• These are costlier.
• Inaccurate.	• Accurate.

4. **Explain rotary or angular position measuring transducers?**
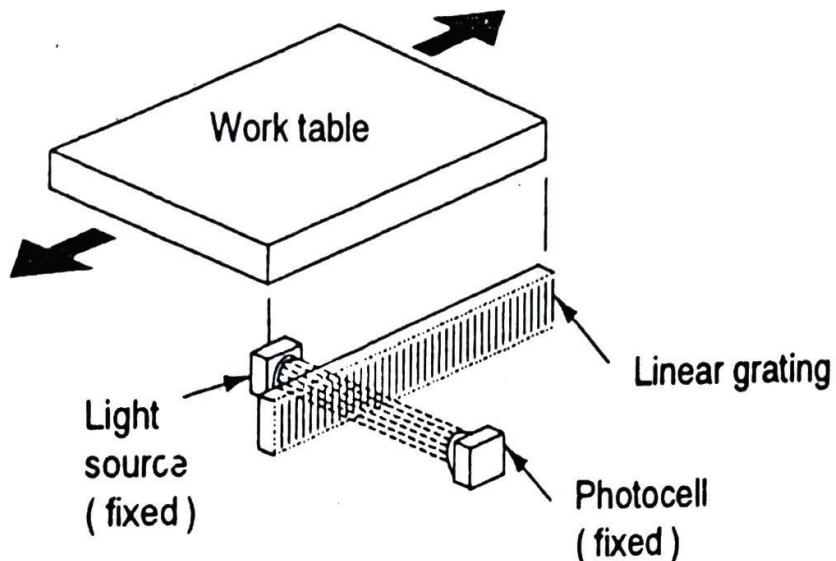
   Ans: Angular position measuring transducers operate by measuring the angular speed of a rotating element, normally of a lead screw. From the known value of lead of the lead screw, movement of worktable or machine slide is calculated by the control system. Most commonly used angular position measuring transducers operate on the photoelectric principle. Such a transducer is shown in fig.

Fig. 3.3. *Angular position measuring transducer*

5. Explain linear position measuring transducers?

Ans: Linear position measuring transducers also operates on the photoelectric principle. The linear measuring system measures the displacement of the machine slide from a fixed datum. A linear measuring system consists of a precision linear scale engraved with close spaced alternate transparent and opaque parallel lines as one unit and a photocell and light source as the second unit. Principle of linear measuring system is shown in fig.
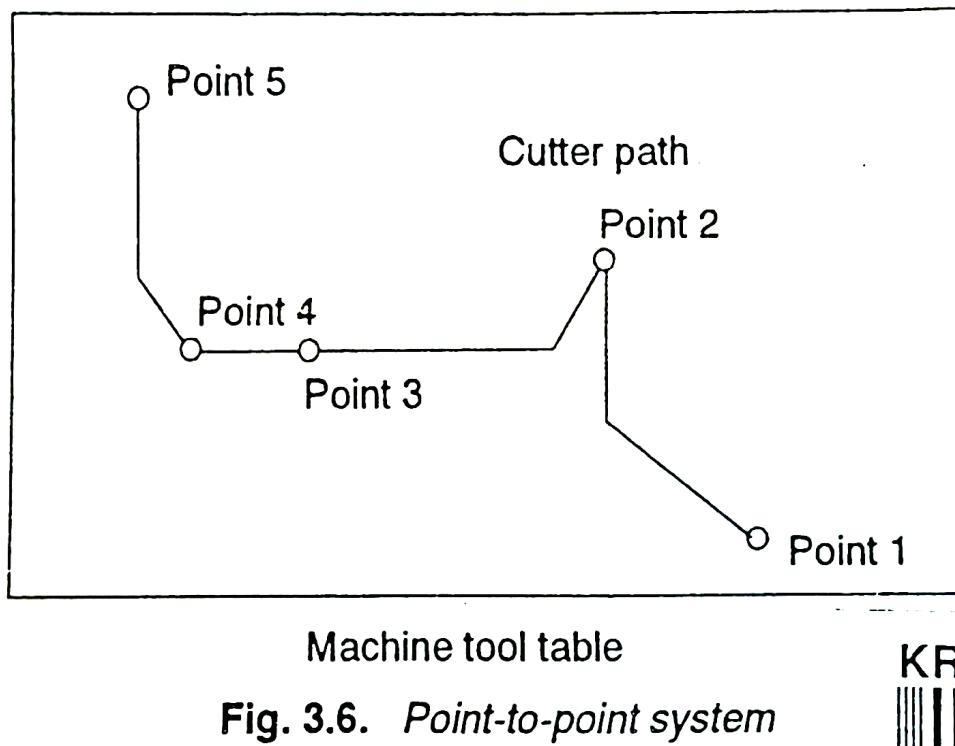
Fig. 3.5. *Linear position measuring transducer*

6. Explain with sketch point-to-point control system?

Ans: Point to point control is one where accurate positional control is required only to place the machine slides in fixed position and the machine tool slide is required to reach a particular fixed coordinate point in the shortest possible time. Point to point system is suitable for drilling, boring, tapping, punch presses and jig boring machines. An example of machining by point-to-point control system is shown in fig.

Point - to - point control follows a
somewhat irregular straight line path

Point 5

Cutter path

Point 2

Point 4

Point 3

Point 1

Machine tool table

KR
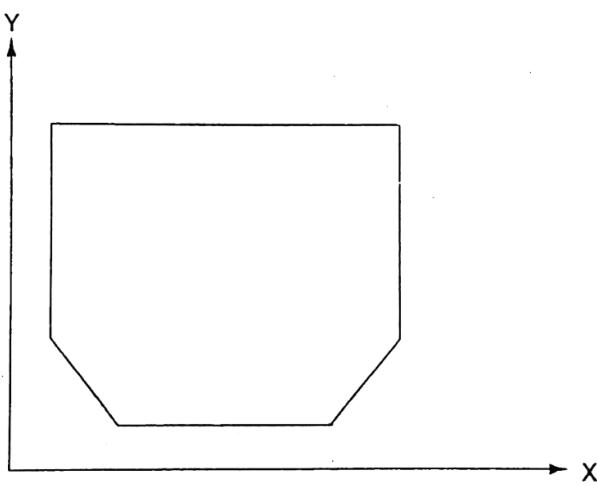
Fig. 3.6. *Point-to-point system*

**7. Explain straight-line control system?**
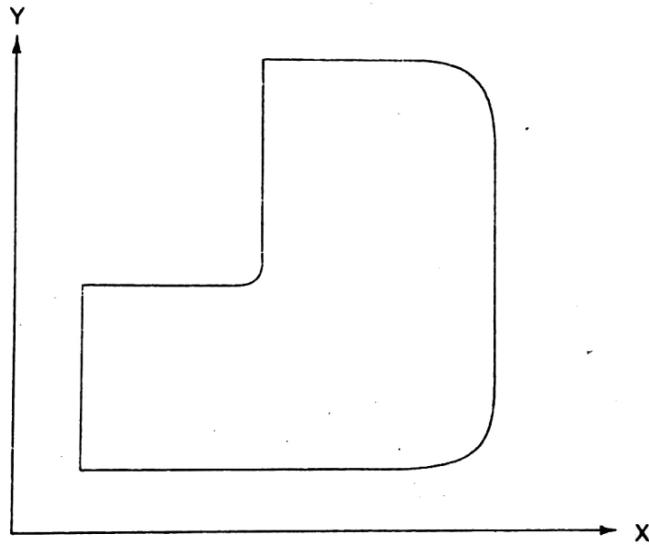
Ans: Straight line or straight cut CNC system is an extension of point-to-point control system with the provision of machining along a straight line as in case of milling and turning operations. This is obtained by providing movement at controlled feed rate along the axis in the line of motion. It is possible to machine along diagonal lines with movement in two axis at a controlled feed rate.

Y

X

Fig. 3.7. *Straight line system*

8. Explain continuous path or contouring control system?
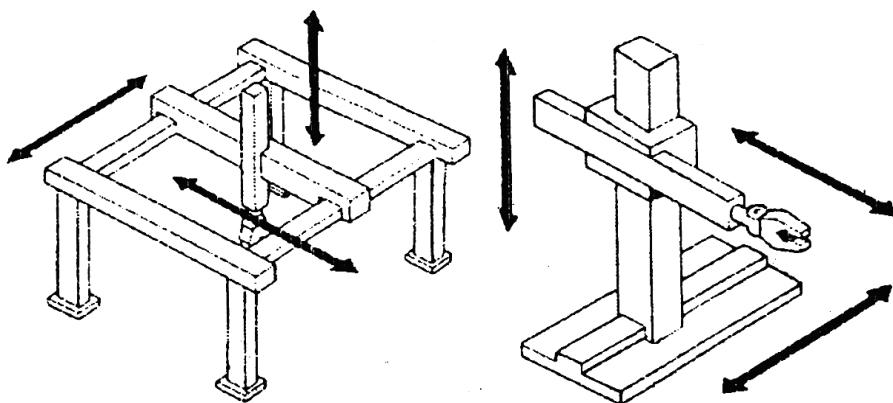
Ans: The contouring system is a high technology and most versatile control systems. The contouring system generates a continuously controlled motion of the tool and work piece along different coordinate axis. This control system enables the machining of profiles, contours and curved surface. A system designed for continuous path machining can, of course, be used for point-to-point and straight line machining but that will result in under utilization of the system.

Fig. 3.8. *Contouring system*

9. **Explain with sketch Cartesian coordinate system?**
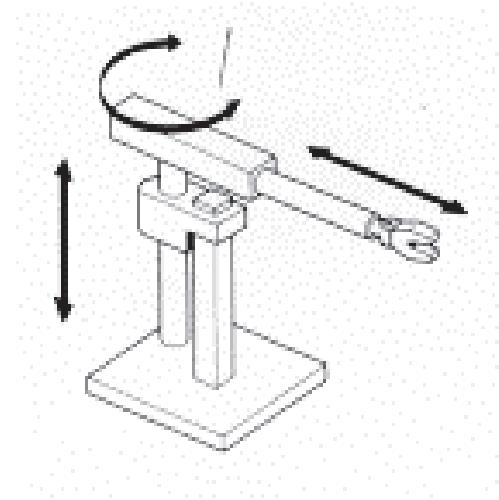
   Ans: The Cartesian configuration provides for three linear axes of movement at right angles to each other. The modes of movement are similar to those of a milling machine, providing movement in X, Y and Z-axes. It may also be termed a rectangular configuration since its working range sweeps out a three dimensional rectangular volume.

Fig. 8.2 Cartesian robot configuration

10. **Explain with rough sketch cylindrical co-ordinate system?**

Ans: The cylindrical configuration combines both vertical and horizontal linear movement, with rotary movement in the horizontal plane about the vertical axis. It is so called because its motions sweep out a partially cylindrical working volume. This robot configuration finds application finds application in radial work piece layouts where the work is approached primarily in the horizontal plane and where no obstructions are present. Such applications include small circular manufacturing cells or loading and unloading applications, servicing conveyor systems. Linear movements through both vertical and horizontal apertures are easily accomplished. A typical cylindrical configuration is illustrated in fig.

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Chapter No: 04

"Tooling for CNC Machines"

Part - A

A. Fill in the blanks with appropriate words: (1 Mark Each)

1. ATC Stands for_____.
2. Multipallet system enables the operator to load the work piece on _____ while machining
3. The non-productive time, the CNC machines are provided with _____system.
4. At high cutting speeds and feed used in CNC, machine_____tools are normally used.
5. The special design features of CNC machines have resulted in use of _____cutting speed.
6. Tool holder can reduce the tool change time to about _____to 5 seconds.
7. _____ devices are available for the presetting of tools.
8. Tool holders used on CNC machine tools should be _____.
9. _____actuation is widely used in work holding devices.

Answers:

A. Fill in the blanks

Q.No.	Answers:	Q.No.	Answers:
1	Automatic Tool Changer	6	**3**
2	Pallet	7	Special pre setting
3	Automatic pallet Change	8	quick changing
4	Brazed	9	Hydraulic and Pneumatic
5	Higher	10	

B. Multiple choice questions: (1 Mark Each)

1. **Tool numbering is done by the letter _____ in part programming.**

   a) F

   b. T

   c) N

   d. S

2. **Automatic tool changer machine tools have automatic tool &_____**

   a) Tools

   b. Magazines

   c) Changer

   d. None of the above

3. **The tools are set to known dimensions away from the machine tools are known as _____**

   a. Tools

   b. Tool presetting

   c. Qualified tools

   d. None of the above

4. **To minimize the tool change and tool setting time the CNC machine uses _____&_____**

   a.Tools and magazines

   b. G-code & M-code

   c. Preset & qualified tools

   d. none of the above

5. **_____ Types of CNC machines are very commonly used with 5 pallets.**

   a. Twin pallet

   b. Multiple pallet

   c. Pallet

   d. None of the above

6. **Three adjustable buttons on tools shank are also known as _____**

   a. Qualify tools

   b. Semi qualify tools

   c. Tools

   d. All of the above

7. **In how many ways CNC machine tool systems can be classified.**

   a. 3   b. 5

   c. 4   d. 2

8. **What is the long form of CNC?**

   a. Computer number control   b. Computer numerical control

   c. Calibrated numerical control   d. None of the above

9. **Tool magazine with up to _____ tools are quite commonly available**

   a. 60   b. 50

   c. 30   d. 40

10. **The tools for successive operation is selected during _____machining operation**

   a. Forward   b. Previous

   c. Before   d. None of the above

Answers:

B. Multiple choice questions

Q.No.	Answers:	Q.No.	Answers:
1	b. T	6	b. Semi qualify tools
2	b. Magazines	7	a. 3
3	b.Tool presetting	8	a. Computer number control
4	c. Preset & qualified tools	9	a. 60
5	a.Twin pallet	10	b) Previous

C. Answer the following questions: (2 Marks Each)

1. **What purpose quick changer used in CNC machine?**

   Ans: Tool holder are used in CNC machine tool for quick changer

2. **How many tool turrets available in turning centre?**

   Ans: Turning centre are available with the tool turret containing 8 to 12 tools.

3. **What are qualified tools?**

   Ans: Qualified tools are the tools on which the position of the cutting is guaranteed.

4. **What is semi qualified tools?**

   Ans: The tools which are having free adjustable buttons are known as semi-qualified tools.

5. **Define tool presetting?**

Ans: The tools are set to known dimensions away from the machine tools is known as tool presetting.

6. **Define Indexable inserts?**

   Ans: Indexable carbide inserts are used to take up higher cutting speed and to minimize the tool change time.

7. **Briefly explain for what purpose tooling in CNC machine used?**

   Ans: The main purpose for tooling in CNC machine is to provide Rigid & Withstand High metal removal rates.

8. **What is the percentage of metal cutting in CNC machine tool?**

   Ans: CNC machine tools are expected to cut metal for 70% to 80% of the machining time.

9. **What does tooling for CNC machine includes?**

   Ans: The tooling for CNC machine includes the cutting tool, and work holding devices.

10. **What purpose semi qualified tools are checked?**

    Ans: Semi Qualified tools are regularly checked and maintain to ensure the dimension correction.

Part - B

I. Answer the following questions: (3 Marks Each)

1. **Briefly, explain tool holder?**

   Ans: tool holders used on CNC machine tools should be quick changing type and should be capable of being pre-set. Since in the modern CNC machines, there is a provision for automatic tool changing, the quick changing type tool holders can reduce the tool change time to about 3 to 5 seconds.

2. **Explain tool selection cycle?**

   Ans: The tool for successive operation is selected during the previous machining operation. The selected tool comes to the tool change position, whenever the tool selection command is received by the system.

3. **What do you mean by Multi-pallet machines?**

   Ans: The CNC machines are provided with automatic pallet change stems. Twin-pallet CNC machines are very common but machines with up to 5 pallets are also being used. The multi-pallet system enables the operator to load the work piece on one pallet while machining of work piece on second pallet is going on. This helps in rapid change of work piece, thereby reducing the idle time of the machine.

4. **Explain in detail Tool Transfer Cycle?**

   Ans: In this part of the tool change cycle, the tool which is lying selected in the magazine, is transferred to the spindle and the tool which is in the spindle is transferred to the magazine. Before the tool transfer takes place, the spindle is turned off and moves to the tool change position, so that the tools will not hit the work piece.

5. **Briefly Explain Indexable insert.**

   Ans:

   ➤ Indexable carbide inserts are used to take up higher cutting speed

   ➤ Indexable carbide inserts are used to minimize the tool change time

   ➤ Indexable carbide inserts are made of Tungsten carbide

6. **Explain Turning center?**

   Ans:

   ➤ Turning centers are available with tool turret containing 8 to 12 tools

   ➤ In turning center tool change command is received by the control system

   ➤ In turning center tool turret moves to a fix tool change position.

7. **Explain Introduction of CNC machine tooling?**

   Ans:

   ➤ CNC machine tooling are used were higher cutting speed, feeds are required

   ➤ Tooling's should be able to withstand higher cutting forces in the process

   ➤ CNC machine tool help to reduce the down time to minimum possible time

8. **What purpose tool holders are used in CNC machine toolings?**

   Ans:

   ➤ Tool holders are used on CNC machine tool for quick changing

   ➤ Tool holders should be capable of being preset

   ➤ Quick changing type holders can reduce the tool changes trim to about 3 to 5 seconds.

9. **What is the purpose of ATC?**

   Ans:

   ➤ ATC consist of a tool magazine for storing the tools

   ➤ ATC are used for transferring the tool from tool magazine to the spindle

   ➤ ATC magazine are quite commonly available with 60 tools.

10. **What purpose coolant fed tools are used?**

Ans: Coolant fed tools are used, were the coolant is fed to the cutting edge through a centrally drilled hole in the shank of the tool, also there is interlock in the system so that if the coolant supply is not there.

II. Answer the following questions: (5 Marks Each)

1. **Explain work-holding devices in CNC machines?**

   Ans: The numerically controlled machines are capable of performing a number of operations using different tools, on different faces of a component in a single setting. His requires that the component should be accessible from different sides without changing of clamps or re-positioning of component. The work-holding device has to bear multidirectional cutting forces. So additional demands are made on work holding devices in numerically controlled machine tools. To reduce the clamping/ unclamping time, hydraulic and pneumatic actuation is widely used in work holding devices.

2. **Write the applications and features of work holding devices in CNC machines?**

   Ans: The following are the features of work holding devices are as follows:
   1. It should restrict the linear and rotary motion of the component.
   2. The component should not distort or deflect due to cutting forces in the process.
   3. It should facilitate quick loading and unloading of the component.
   4. It should not interfere with the cutting tools.
   5. It should provide for easy removal of chips.
   6. It should be safe.

3. **What is tool pre-setting? How do the preset tools help to increase production?**

   Ans: The tools are set to known dimensions away from the machine tools. The pre-setting of tools can be planned and carried out in advance, So that tools are available to ensureContinuity of production and minimize down time due to tool set-up on job changesSpecial pre-setting devices are available for the pre-setting of tools. Pre-settings donewith the held in the holder, so that the assembly i.e. tool holder and cutting tool can be straightaway fitted on the machine.

4. **Explain in detail automatic tool changer?**

Ans: The CNC machines are designed to perform a number of operation in a single setting of the work piece. To reduce the downtime in changeover from one operation to the next, the CNC machines are equipped with automatic tool change facility. The tool is automatically selected and changed based on the tool control function (T-word) in the part programme. Turning centres are available with the tool turret containing 8-12tools.as the tool change command is received by the control system, the tool turret moves to a fixed tool change position and the required tool comes to the cutting position. On the machining centers, automatic tool changers (ATC) are provided to reduce the idle time between changes over from one operation to another.

5. **What are characteristics require for tools used in CNC machine?**

   Ans: The tools used in cnc must have following characteristics are as follows
   1. Rigid to withstand high metal removal rates
   2. Capable of being pre-set and re-set in the shortest possible time to keep the down time to minimum.
   3. Accurate enough to produce repetitive accuracy on the job .In conventional machines, the cutting too cuts metal for about 25% of the total machining time
   4. Whereas the CNC machine tool are expected to cut metal for 70 to 80% of the time.

6. **What do you mean by indexable inserts?**

   Ans: Indexable carbide inserts are used to take up higher cutting speed and to minimize the tool change time. Since the actual cutting time is more in CNC machines, the consumption of cutting tools is also more. The tool change time with the brazed tool is many times more compared to tool change time with indexable inserts, where the inserts is taken out and indexed. Harder and special grade carbides should be used to achieve faster rate of metal removal. Indexable inserts are available in various shapes and with varying geometry.

7. **Why down time has to be reduce in CNC machine tool camper to conventional machine?**

   Ans: In conventional machine, the cutting tool cuts the metal for about 25% of the total machining time whereas the CNC machine tools are expected to cut metal for 70% to 80% of the time, since the CNC machines are very costly, the down time of this machine has to be reduce to a minimum.

8. **How to minimize tool marks on machine surface?**

Ans:

➢ Doubling the cutting speed seems to be increasing the cutting forces enough to either affect the way heat is moving into the chip

➢ Try to increase the spindle speed though this may result in unacceptable tool life.

➢ The different types of tool wear, if the speeds and feeds control. Might result in tool rupture or not. You could also try adding a wiper insert to one of your insert pockets.

➢ Wiper insert could reduce the chattering marks on the surface.

➢ Proper coolant should be provided to increase tool life.

9. Explain solid HSS tooling in CNC machine?

Ans:

➢ The solid HSS tooling is employed in machining application were proper cutting fluids are used

➢ HSS tooling are used to improve the surface finish

➢ HSS tooling are used to increased tool life and accurate dimensions

➢ The overhang of the HSS tool should be kept minimum

➢ In HSS tooling higher cutting speed and feed rate can be given

10. Explain different types of Tool holders in CNC machines?
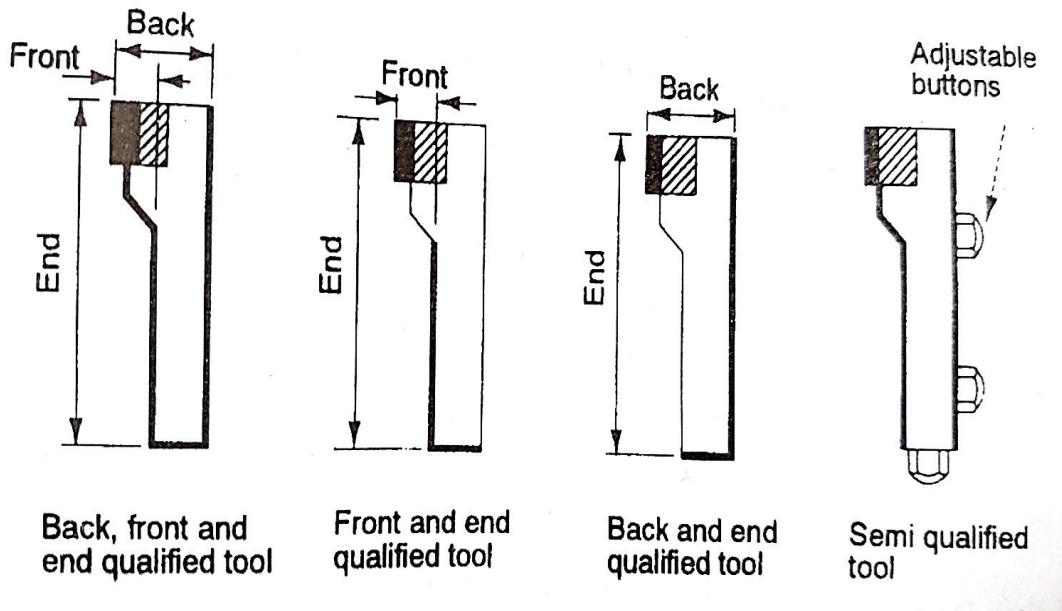
Ans: Tool holders vary based on the method used to hold the end mill in place. CNC milling tool holder types.

➢ **Shrink fit holders:** This type of holder uses heating and cooling to apply clamping force to the cutting tool. Shrink fit holders offer powerful grip and can dramatically extend tool life.

➢ **Collet chucks:** A collet chuck grips the end mill with a slotted collar. Standard collets are sized by millimeter, and they can be customized as well.

➢ **End mill holders:** These parts use a setscrew to secure the cutting tool. They have small nose diameters and are available in a variety of lengths.

III. Answer the following questions: (8 Marks Each)

1. **Explain which neat sketch qualified tools?**
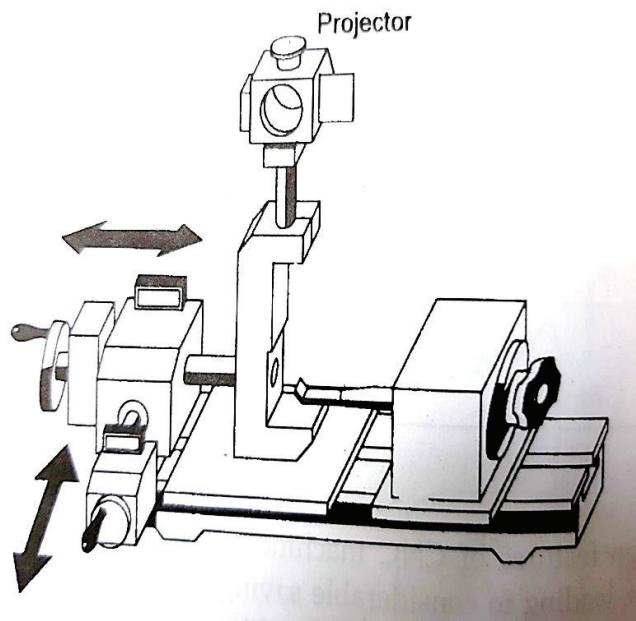
   Ans: Qualified tools are the tools on which position of the cutting tool is guaranteed

| Back, front and end qualified tool | Front and end qualified tool | Back and end qualified tool | Semi qualified tool |

- Within closed limit of accuracy from a specified datum on the tool holder.
- The qualified dimensions are applied to the tool tip from the three datum's.
- Tool holder is fixed and known precise position of the tool tip is known and accurate positioning on the machine tools is possible.
- Hard metal inserts are ideally suited for qualified tooling.

2. With neat sketch, explain tool Pre-setting devices?

Ans: Special Pre-setting devices are available for the pre-setting of tools. Pre-setting is done with the tool held in the tool holder so that the assembly i.e. tool holder and cutting can be straight away fitted on the machine.

3. **Explain Automatic tool changer in CNC machines?**

   Ans:

   1. The CNC machines are designed to perform a number of operations in a single setting of the work piece.
   2. To reduce the down time in change over from one operation to the next.
   3. The CNC machines are equipped with automatic tool change facility.
   4. The tool is automatically selected and changed based on the tool control function (T-word) in the part program.
   5. Turning centre are available with the tool turret containing 8-12 tools.
   6. On the machining centre's, automatic tool changers (ATC) are provided to reduce the idle time.

4. **Discuss the method used to reduce the idle time on CNC machine?**

   Ans: The method used to reduce the idle time on CNC machine is as follows:

   1. On CNC, machining centre automatic tool changers are used.
   2. Idle time between change e over from one operation to another is reduced.
   3. The ATC consist of tool magazine for storing the tools.
   4. Tool change unit are used for transferring the tool from the tool magazine.
   5. The initial positioning of the various tool is Fed to the control system.
   6. Tool magazine with up to 60 tools are quite commonly used.
   7. Tool change cycle consist of two parts, to reduce the idle time.

5. **Briefly explain tool holders in details?**

   Ans:A tool holder is a component of machining that keeps in place the end mill. Its purpose is to keep the tool as precise and firmly in place as possible, as a barely perceptible increase in run out may ruin your project or break your cutting tool.

   Another important thing to consider when choosing a CNC machineholder is the amount of time it takes to adjust end mills because it affects the bottom line directly.

   Types

   Tool holders vary based on the method used to hold the end mill in place.

   ➢ **Shrink fit holders:**
   ➢ **Collet chucks:**
   ➢ **End mill holders:**
   ➢ **Tap holders:**

6. Explain benefits of multi pallet machines?

Ans: Benefits of Automatic Multi-Pallet machines:

- ➢ Heavy/large work pieces easily loaded outside the machine
- ➢ Increased machine and operator productivity
- ➢ Jobs can easily be interrupted for emergency jobs (JIT)
- ➢ Pallets easily interchange between machines or departments
- ➢ Exchange pallet in seconds with a +/- .0001" (.0025 mm) repeatability

7. Briefly Explain work holding devices in CNC machine tool.

Ans: The numerical control machine is capable of performing number of operation using different tools on different faces of a component.

- ➢ Work holding devices has to be multi directional cutting forces
- ➢ To reduce the clamping and unclamping time Hydraulic and Pneumatic actuation it is in work holding devices
- ➢ Work holding devices should be fool proof
- ➢ Work holding devices should not interfere with the cutting tools
- ➢ Work holding devices permit number of operation on different plain in a single setting
- ➢ Work holding devices should provide for easy removal of chip
- ➢ Work holding devices should be adaptable to automatic loading /unloading of components
- ➢ Work holding devices should be safe.
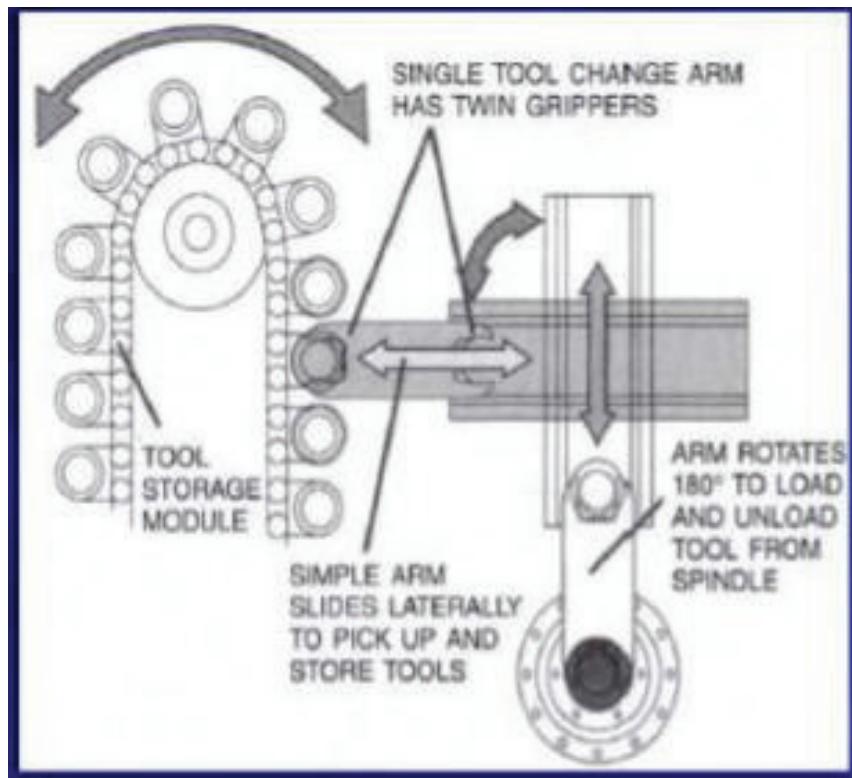
8. Draw a neat sketch of Indexable Inserts?

Ans:

1. Insert Shape		
Symbol	Insert Shape	
H	Hexagonal	⬡
O	Octagonal	⬯
P	Pentagonal	⬠
S	Square	▢
T	Triangular	△
C	Rhombic 80°	▱
D	Rhombic 55°	▱
E	Rhombic 75°	▱
F	Rhombic 50°	▱
M	Rhombic 86°	▱
V	Rhombic 35°	▱
W	Trigon	△
L	Rectangular	▭
A	Parallelogram 85°	▭
B	Parallelogram 82°	▭
K	Parallelogram 55°	▱
R	Round	◯
X	Special Design	▱
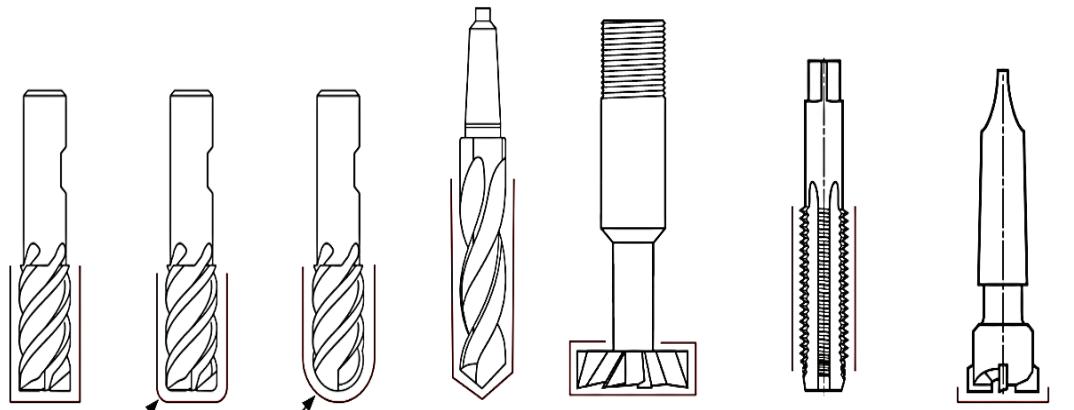
9. Draw a neat sketch of Automatic toll changer?

Ans: Automatic Tool chnager

10. Explain with neat sketch different types of cutting tools in CNC machine?

Ans:

Flat head   Bull head   Ball head   Drill   Slot cutter   Threading tap   Face cutter

By: Shri. Ramakant Math (GTTC, Belagavi)

"**Tool Changing and Pallet Changing**
(ATC & APC)"

Part - A

A. Fill in the blanks with appropriate words: (1 Mark Each)

1. The tool changer function is_____
2. APC stands for_____
3. In majority of machining centre control tool offset is cancelled by the ____ code.
4. Tool length offsets are used as compensation for tools that differ in _____.
5. Geometry offsets are used as compensation for tools that differ in _____.
6. In CNC control system _____ensures that programming is independent of tool dimensions.
7. The distance between the gauge plane on the spindle nose and tip of the cutter is known as____
8. _____ feature permits programming to drawing dimension of the workpiece and allows the calculation of the equidistant tool path to the control system.
9. The tool radius compensation left is given by ____ command.
10. The tool radius compensation right is given by ____ command.
11. _____ command cancels G41 or G42
12. Tool changing function is_____
13. 13) Spindle stop function is ____
14. 14) The meaning of "H" in pars programs is _____
15. 15) The meaning of "T01" in M06T01 in FANUC program is_____

Answers:

A. Fill in the blanks

Q.No.	Answers:	Q.No.	Answers:
1	Automatic	9	
2	pallet changer	10	
3		11	
4		12	
5		13	
6		14	
7		15	
8			

B. Multiple choice questions: (1 Mark Each)

1. Turning centre are available with the tool turret containing _____tools

    a. 8-12   c. 20-30

    b.10-15   d.50-60

2. In majority of machining centre control tool offset is cancelled by the ___ code.

    a. G50   c. G49

    b. G43   d. G44

3. Tool length offsets are used as compensation for tools that differ in.

    a. width   c. length

    b. thickness   d. diameter

4. Geometry offsets are used as compensation for tools that differ in _____.

    a. width   c. length

    b. Thickness   d. diameter

5. In CNC control system _____ensures that programming is independent of tool dimensions.

    a. width   c. length

    b. thickness   d. Tool compensation

6. The distance between the gauge plane on the spindle nose and tip of the cutter is known as____

    a. width compensation   c.Tool length compensation

    b. thickness compensation   d. diameter compensation

7. _____ feature permits programming to drawing dimension of the workpiece and allows the calculation of the equidistant tool path to the control system.

    a. width compensation   c.Tool length compensation

    b. Thickness compensation   d. Tool redius compensation

8. The tool radius compensation left is given by ___ command.

    a. G40   c. G41

    b. G42   d. G44

9. The tool radius compensation right is given by ___ command.

    a. G40   c. G41

    b. G42   d. G44

10. _____ command cancels G41 or G42

    a. G40   c. G50

    b. G43   d. G44

11. Tool changing function is_____

    a. M06   c. M05

b. G43   d. G44

12. Spindle stop function is _____

    a. M05   c. G50

    b. G43   d. G44

13. The meaning of "H" in pars programs

    a. Tool length offset   c. Work offset

    b. Wear offset   d. Geometry offset

14. What is "T01" in M06T01 in FANUC PROGRAM?

    a. Tool offset no: 1   c.Tool no: 6

    b.Tool no: 1   d.Tool wear offset   no: 01

15. What is the distance from X0, Y0, Z0 of machine zero to work zero in X, Y, Z direction?

    a. Tool length offset   c. zero offset

    b. wear offset   d) Tool wear offset

16. What is 'D' command in tool offset?

    a. Tool material   c. Length of cutter

    b. wear of cutter   d.Tool radius

Answers:

B. Multiple choice questions

Q.No.	Answers:	Q.No.	Answers:
1	a. 8-12	9	b. G42
2	c.G49	10	a. G40
3	c. length	11	a. M06
4	d. diameter	12	a. M05
5	d. Tool compensation	13	c. Work offset
6	c. Tool length compensation	14	
7	d. Tool redius compensation	15	
8	c. G41	16	

C. Answer the following questions: (2 Marks Each)

    1. **What is tool selection cycle?**

Ans: The tool for successive operation is selected during the previous machining operation. The selected tool comes to the tool change position, whenever the tool selection command is received by the system.

2. **What is tool Transfer Cycle?**

   Ans: In this part of the tool change cycle, the tool whitch is lying selected in the magazine is transferred to the spindle and the tool which is in the spindle is transferred to the magazine. Before the tool transfer takes place, the spindle is turned off and moves to the tool change position, so that the tool will not hit the workpiece.

   3.**What are the kinds of tool changers?**

   4. **Write about Linear tool changers.**

5. **Write about Tool turrets.**

6. **Write about Tool Chains.**

7. **Write about Robot tool changers.**

8. **What is tool length offset?**

9. **What is Geometry offset?**

10. **What is TNRC?**

11. **What is cutter redius compensation?**

12. **Write about tool nose redius compensation.**

13. **Write about pallet changers.**

14. **What is APC?**

15. **What are the types of pallet changers?**

Part - B

I. Answer the following questions: (3 Marks Each)

1. **What is tool changer?**

   Ans: Most of the time, different cutting tools are used to produce one part of a machine. The tools have to be replaced quickly for the next machining operation. Owing to this reason, majority of NC/CNC machine tools are equipped with automatic tool changers, such as magazines on machining centres and turret on turning centres. They allow tool changing without the intervention of operator. Typically, an automatic tool changer grips tool in the spindle, pulls it out, and replaces it with another tool.

2. **What is tool offset?**

   Ans: Tools differ in length as well as in diameter, making compensation in slide movement necessary to accommodate the dimensional variation of the tools. This compensation is known as the tool offset. Once the tool offset is established, the slide movement is automatically adjusted according to the value that is set.

3. **How tool offset is defined in defferant cnc systems?**

   Ans: The Tool Offset in different systems is defined as follows.

   Fanuc –   T 00 00

           Tool Offset number

           Tool selection

   Sinumerik -   D 0 0

4. **Write about Linear tool changers.**

5. **Write about Tool turrets.**

6. **Write about Tool Chains.**

7. **Write about Robot tool changers.**

8. **What is tool length offset?**

9. **What is Geometry offset?**

10. **What is TNRC?**

11. **What is cutter redius compensation?**

12. **Write about tool nose redius compensation?**

13. **Write about pallet changers.**

14. **What is APC?**

15. What are the types of pallet changers?

II. Answer the following questions: (5 Marks Each)

1) What are types of tool offsets? Explain.

Ans: There are two types of tool offset.

1) Tool length offset
2) Geometry (diameter) offset

As the name suggests, tool length offsets are used as compensation for tools that differ in length. In the same manner, Geometry (diameter) offsets are used as compensation for tools that differ in diameter.

Tool offset enable using the same part program for any tool length and any tool diameter. This feature is one of the greatest advantage of CNC machines over conventional machines.

Tool offset have a direct effect on the part size, but they do not offset the part program. This means that the operator may change the offset value a number of times if needed but different offset values are executed by the same offset number in the program. Thus, the offset may also be described as the operator's way of programming the part.

2. What are the kinds of tool changers? Explain.

3. What is tool Length Offset? Explain

4. Write about Tool Offset Adjustment.

5. Explain T0303.

6. What are the Benefits of Automatic Pallet Changer in CNC Machine production?

7. What is pallet in CNC Machine?

8. What you mean by automatic tool changer?

9. Write about Automatic Pallet Changer mechanism used on machining?

10. What do you mean by automatic tool changer?
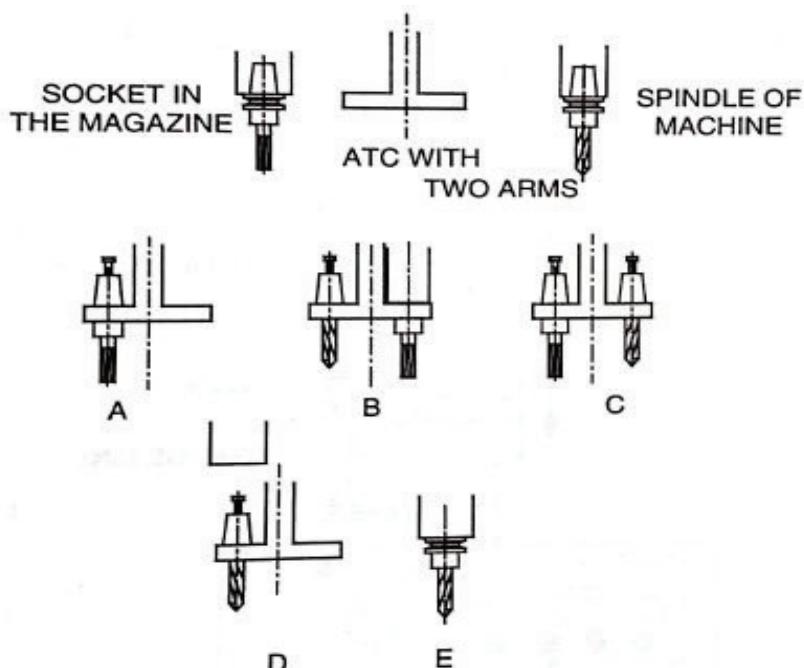
11. Describe the concept of "Tool Offset" for CNC machine with suitable example?

III. Answer the following questions: (8 Marks Each)

1. **Explain sequence of operation of an Automatic Tool Changer?**

   Ans: The sequence of operation odf ATC is as follows:

   a) ATC moves from the parking position to grab the ends mill.

   b) ATC pulls out the end mill from socket A.

   c) ATC moves to the spindle, grabs the drill, and pulls it out B.

   d) ATC rotates through 180 degrees about is axis, and inserts the end mill in to the spindle C.

   e) The magazine indexes and brings the socket to receive the drill to the change position.

   f) ATC inserts the drill into the socket.

   g) ATC moves to the parking position.

**Fig.**   Operation of an Automatic Tool Changer
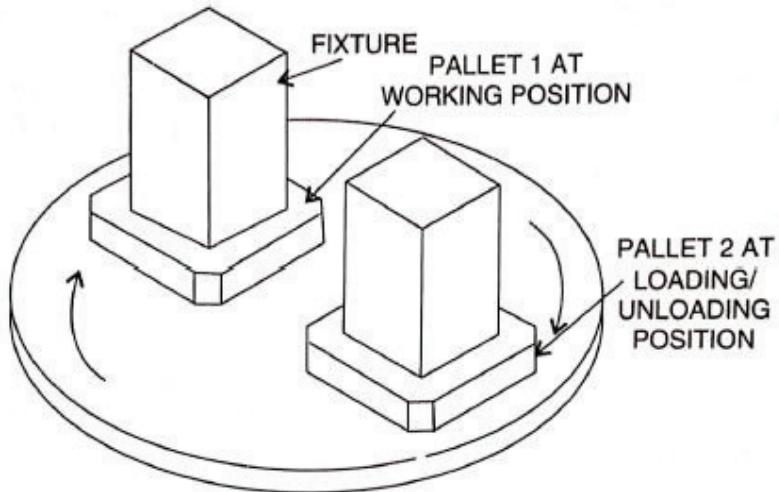
2. **What is Automatic Pallet Changer? Explain in detail.**

   Ans: The setting up time and operation time of components machined in machining centre are usually high. During set up time, the machine which will have several hundreds f Rupees of machine hour rate (MHR) will be idle.

   A solution to avoid this kind of loss is to have a second table on which the next work piece can be set up while one component set upon one table is being machined. The worktables are called pallets. While the component is one pallet is being machined, the operator sets up the next component of the second pallet.

   After completing the first component, the pallet concerned moves to the unloading position and the second pallet moves to the machining position. This will take only few seconds. Thus, the interval between finishing of one part and starting the machining of
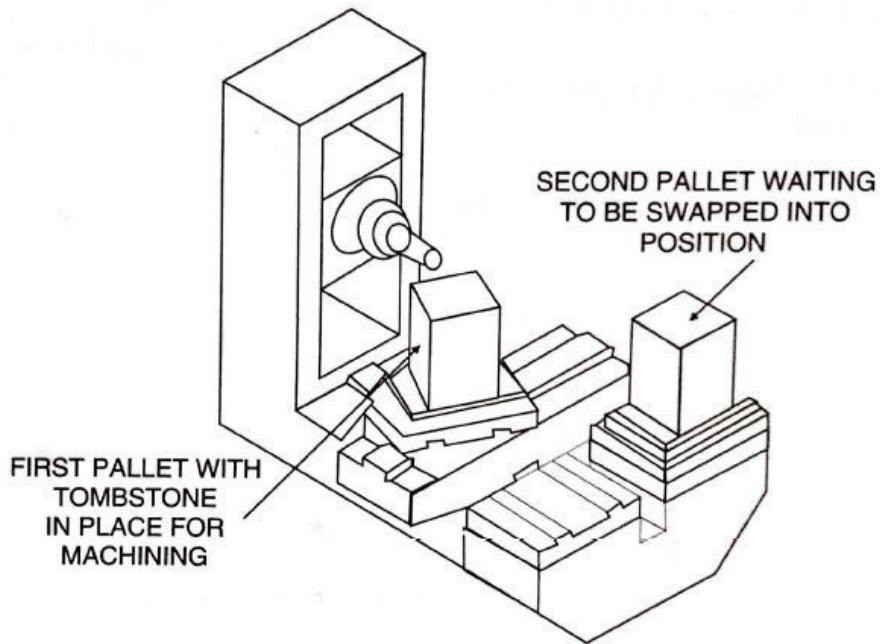
another part will be only a few seconds. The operator can now unload the finished component and then load the new component. The mechanism for changing the pallet is called an automatic pallet changer (APC). The operation of an APC is illustrated in fig.. A machine can have 7, 8, or even 32 pallets. The CNC system can be programmed to machine the component one after another. Thus, APC is a very useful opting for unattended manufacturing.

Fig.   Automatic Pallet Changer

There are two types of pallet changers:
- Rotary Pallet Changer
- Shuttle type Pallet Changer

Fig.   Pallet Changer in a Machining Centre

3. Justify need of cutter radius compensation given for CNC milling programming.

4. Differentiate between automatic tool changer (ATC) and automatic pallet changer (APC) of CNC

5. Define the "work zero postion" and "Machine zero position" of CNC machine.

6. Write meaning of followings

a) M03   b) M05   c) M06   d) T00e) D00

7. What are the dis advantages of automatic pallet changer?

8. Explain different types of automatic pallet changers with neat sketch?

9. How does an automatic tool changer works?

10. Describe the principle of workining of an automatic pallet changer and automatic tool changer.

11. Explain cutter radius compensation and tool length compensation.

12. What are the components of Automatic Tool Changer?

13. What are the advantages of ATC?

14. Explain Automatic Tool changing Mechanism on turning center.

15. Write about ATC on sheet metal working machinery.

By: Shri. Prashant Sutar (GTTC, Dharwad)

Chapter No: 06
"Part Programming for Turning"
Part - A
A. Fill in the blanks with appropriate words: (1 Mark Each)
1. Thread cutting can be done on CNC lathe using _____code.
2. Tool number in CNC machine is specified by _____
3. _____is the code for the fixed turning cycle
4. A CNC lathe which can also perform milling operation is called_____
5. Deep hole drilling cycle is also called _____
6. In the block turning program G28 U_W_ hear U&W are parallel axis for _____&_____
7. To control the spindle speed in CNC turning machine _____G-codes are used
8. In CNC lathe the code for spindle rotation CCW is _____
9. For rapid traverse _____G-code is used
10. The part program for any component is developed relative to _____

11. In case it is desired that the cutting tool should not immediately return after touching the programmed position _____ function is used

12. Each line in CNC program ends with _____

13. In turning program, _____&_____ will denote the center of the arc for circular profile.

14. Rough turning cycle is _____

15. Machining in linear interpolation is done using _____ code

16. _____ G-code is used for 2nd reference point

17. Automatic Zero return in CNC lathe the G-code is used _____

18. For AUTO TOOL CHANGE in CNC lathe _____code is used

Answers:
A. Fill in the blanks

Q.No.	Answers:	Q.No.	Answers:
1	G33	10	Zero Points
2	'T'	11	Dwell
3	G81	12	EOB
4	Turn mill	13	I&K
5	Peck Drilling Cycle	14	G71
6	X & Z	15	G01
7	G95&G96	16	G33
8	8. M04	17	17.G28
9	9.G00	18	18.M06

B. Multiple choice questions: (1 Mark Each)

1. For cancelation of canned cycle ___ G code is used

   a.G81   b. G79

   c. G80   d. G84

2. For deep hole drilling canned cycle which G-code is used

   a.G82   b. G80

   c.G81   d.G84

3. Standard cycles in part programming are called :

   a.CANNED cycles   b. Tapping cycles
   c. Drilling Cycles   d. Reaming cycles

4. Point-to-point systems are used for _____

a.Reaming   b. Parting

c. Grooving   d. Facing

5. Which word is used to specify tool offset on tuning centre

a.M word   b. T word

c. G word   d. F word

6. Spindle motor used in CNC machine tools for high speed machining

a. AC servo   b. DC servo

c. AC servo with integral spindle   d. stepper motor

7. The type of cutter motion during execution of CNC part program block

N2020 G02 X95.0Y25.0 R10

a.Circular interpolation clock-wise   b.Liner interpolation

c.Circular interpolation counter clock -wise   c.Rapid traverse

8. On turning centre, the machining zero is normally set at

a. Centre of the spindle nose face   b. Tool tip mounted on tool post

c. Dead centre of tail stock   d. None of these

9. The correct syntax of NC block for taper turning operation is

a. N_G01 X_F_   b. N_G01 Z_ F

c. N_G01_X_Y_F   d. N_G01_M_X_Y_F

10. G70 cycle in turning centre programming is used for____

a. Rough turning   b. Finish Turning

c. Threading cycle   d. None of these

11. The G-code used for perform tapping cycle on machining centre

a. G-81   b. G-82

c.G-83   d.G-89

12. The data for preparing the coded instructions, _____

a. Part programming   b. Sub programming

c. Canned cycles   d. None of these

13. On the CNC lathe

   a. 2-D Programming is sufficient   b.3-D Programming is sufficient

    c. 1-D Programming is sufficient   d. None of these

14. For going to home position in CNC lathe which code is used

   a.G39U0W0   b.G28U0W0

   c.G41X0Y0   d.G30X0Y0

15. In CNC turning the unit of feed rate is specified in ___

   a. Feed/Rev   b. Feed/Min

c. Feed /Inch   d. None of these

16. In tool call format on turning centre "T0505" in this 05 & 05 Indicates _____&_____

   a. Machine number & block Number   b. Tool length & Tool offset number

c.Tool Number & tool offset number   d. None of these

17. _____code is used for Grooving cycle.

   a. G33   b.G38

c.G31   d.G35

18. _____G-code is used for dwell fumction

    a. G05   b. G04

    b. c. G03   d. G01

Answers:

B. Multiple choice questions

Q.No.	Answers:	Q.No.	Answers:
1	a.G81	10	b. Finish Turning
2	a.G82	11	d.G-89
3	a.CANNED cycles	12	a. Part programming
4	a. reaming	13	a. 2-D Programming is sufficient
5	b. T word	14	b.G28U0W0
6	c. AC servo with integral spindle	15	a. Feed/Rev
7	c.Circular interpolation counter clock - wise	16	c.Tool Number & tool offset number
8	b. Tool tip mounted on tool post	17	b.G38

| 9 | c. N_G01_X_Y_F | 18 | b. G04 |

C. Answer the following questions: (2 Marks Each)

1. **Mention the purpose if M06.**

   Ans: The purpose of M06 is-Tool change

2. **In CNC, lathe Define the direction of transverse of the axis?**

   Ans: In lathe, the Z-axis is the axis of the spindle & X-axis is the direction of transverse motion of the tool post.

3. **What is part programming?**

   Ans: Part program is a set of instructions, which instructs the machine tool about the processing steps to be performed for the manufacture of a component.

4. **What is canned cycle?**

   Ans: Canned cycles or fixed cycle may be defined as a set of instructions, inbuilt or stored in the system memory, to perform a fixed sequence of operations.

5. **Which fixed cycle G-code is used for thread cutting?**

   Ans: G-84 code is used for fixed cycle for thread cutting.

6. **Write the common techniques used for repetitive programming?**

   Ans: The common techniques used for repetitive programming are
   1. Subroutines
   2. Do loops
   3. Fixed cycles or canned cycles

7. **Tool should reach the point1 & point 2 with coordinates X15 Y 20 radius of R10. Write the block using proper Preparatory Function.**

   Ans: The block is as follows

   G02 X15.0 Y20.0 R10.0 F100;

8. **Write the example block for showing Stock removal in removing?**

   Ans: Example: N10 G71 U1.0 R1.0;

   N20 G71P1 Q2 U0.2 W0.1 F100;

Part - B

I. Answer the following questions: (3 Marks Each)

1. **Name the types of programming format methods?**

   Ans: The following three programme methods are used for part programming

   a. Fixed block format

   b. Tab sequential format

   c. Word address format.

2. **What is Machine Zero?**

   Ans: The machine zero point is at the origin of the coordinate measuring system of the machine. The machine zero point is fixed and cannot be shifted. The machine zero point is also called 'Home position'.

3. **List out the NC words used in the formation of blocks?**

   Ans: Ans: The NC words used in formation of block are:

   a. Sequence Number (N-word)

   b. Preparatory Function (G-word)

   c. Coordinates (X,Y & Z words)

   d. Feed Function (F-word)

   e. Spindle speed Function (S-word)

   f. Tool Selection function (T-word)

   g. Miscellaneous Function (M-word)

   h. End of block (EOB)

4. **Describe the Given Block. i) G72 W_R_ &ii) G72 P_Q_U_W_F_**

   Ans:G72 is Multiple Facing Cycle

   Where in first block, W-Depth per cut in Z axis   R- Retraction

   In Second block, P-Start block number Q-Ending block number

   U- Finishing Allowance in X axis

   W-Finishing allowance in Z-axis

   F-Feed/rev.

5. **Describe the Given Block.**

   i) G71U_R_ &ii) G71 P_Q_U_W_F_

   Ans:G71 is Multiple Turning Cycle

   Where in first block, W-Depth per cut in X axis   R- Retraction

   In Second block, P-Start block number Q-Ending block number

   U- Finishing Allowance X axis

   W-Finishing allowance in Z-axis

   F-Feed/rev.

6. **List out the canned cycles for lathe operations.**

Ans: Commonly available fixed cycles for lathe operations are:

i. Canned cycle for turning

ii. Canned cycle for threading

iii canned cycle for rough turning

iv Canned cycle for finish turning.

7. **Show the Machine zero point & Work Zero point with sketch.**

Ans: Fig shows the Machine Zero & Work zero in CNC lathe machine.

8. **Explain the functions performed according to following blocks.**

G28 U0 W0

M06 T0202

M30

**Ans:** G28 U0 W0 ------------- Return reference point

M06 Tool Change
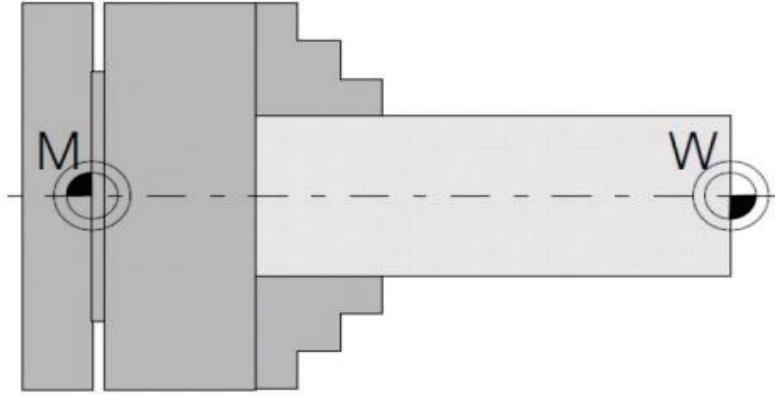
T0202 ------------- for next operation

M30 - Program end

---------------------- & Rewind

II. Answer the following questions: (5 Marks Each)

1. **Write simple turning component program using absolute value.**

Ans: N10 P02 G71 G90 G94 EOB

N20 T01 F200 M03 S800 EOB

N30 G00 X22.0 Z1.0 EOB

N40 G00X0 EOB

N50 G01 Z0.0 EOB

N60 X30.0 EOB

N70 Z-60.0 EOB

N90 G00 Z0.0 EOB
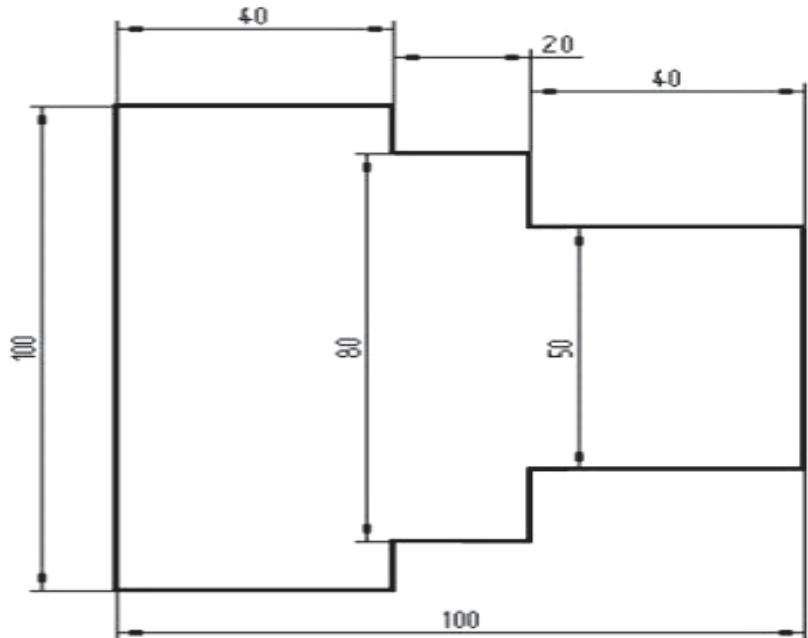
N100 G01 X26.0 EOB

N110 G01 Z-60.0 EOB

N120 G00 X32.00 EOB

N130 Z20.0 EOB

N140 M02 EOB

2. **Explain the function of the following in CNC program**

   GO2, G03, G54, G21, G17, M00, M03, M05, M30

   Ans:

   G02- Circular interpolation C/W

   G03- Circular interpolation CC/W

   G54-Work offset Number 1
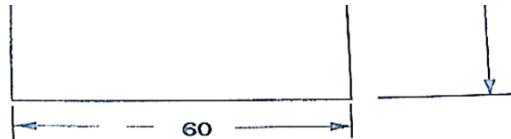
   G21-Metric Data input

   M00- Program stop

   M03- Spindle on C/W

   M05-Spindle off

   M30-End of program & re-call

3. **Write simple turning component program For the following object**
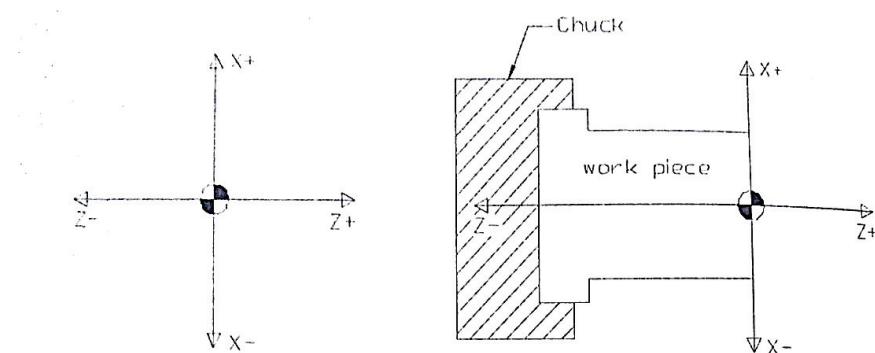
   Ans:

   - N05 G94 M06 T0101
   - N10 G00 X0 Z0 M04 S600
   - N15 G01 X50 F30
   - N20 G01 Z-40

- N25 G01 X80

- N30 G01 Z-60

- N35 G01 X100

- N40 G01 Z-100

- N45 G00 X120

- N50 G00 Z10

- N55 M05

- N60 M30

4. **Explain the axis control in CNC Lathe machine with the help of sketch?**

   Ans:

WHERE: ----▷X0, Z0

X ----▷Diameter

Z ----▷Length

III. **Answer** **the** **following** **questions:** **(8 Marks** **Each)**

1. **Explain the Canned cycle for turning with suitable example.**

   Ans: In order to save part programming time and computer memory, fixed cycle for turning are available in the control system. The programmer has to first write an instruction block to

position the cutting tool at the starting point and then call the fixed cycle for turning as follows:

N10 G81   X-2.0 Z-30.0 F200 EOB
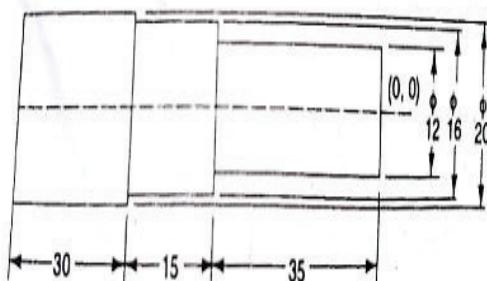
Where,
G81 is the code for the fixed turning cycle
X-2.0 denotes that the depth of cut is 2 mm.
Z-30.0 denotes that the length to be machined is 30 mm.

Example:

The steps required to make this component are:
(i) Turn to 16 mm diameter over a length of 50 mm
(ii) Turn to 12 mm diameter over a length of 35 mm.
The depth of cut should not exceed 1.5 mm and the rotary spe
is 300 rpm and feed rate is to be kept at 200 mm/minute.
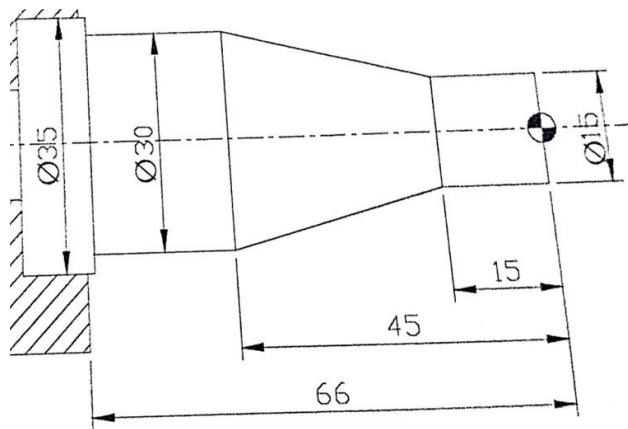
N1	G91	G94 G71 M03 S800 EOB
N2	G00	X20.00 Z0 EOB
N3	G81	X-2.00 Z-50.00 F200 EOB
N4	G81	X-4.00 Z-50.00 F 200 EOB
N5	G81	X-6.00 Z-35.00 F 200 EOB
N6	G81	X.-8.00 Z-35.00 F 200 EOB
N7	G80	EOB
N8	G00	X 25.00 Z 10.00 EOB
N9	M02	EOB

2. Write the taper turning program for given object.

Ans: G21 G40 G90 G98

G28 U0 W0

MO6 T0101

G50S1000 M04

G96 S100 M08

G00X37.0 Z2.0

G71 U1.0 R0.5

G71 P1 Q2 U0.2 W0.1 F100

N1 G01 X15.0

Z0.0

Z-15.0

X30.0 Z-45.0

Z-65.0

X37.0

N2 G00 Z2.0

G28 U0 W0

G97 G98

M06 T0202

G50 S1600 M03

G96 S100 M08

G00 X37.0 Z2.0

G28 U0 W0

G70 P1 Q2 F80

G97

M30

By: Shri. Prashant Sutar (GTTC, Dharwad)

Chapter No: 07

"Part Programming for Milling"

Part - A

A. Fill in the blanks with appropriate words: (1 Mark Each)

1. In the program block feed rate is designated by the latter '_____'
2. In _____format of block, instructions are always given in the same sequence.
3. In coordinate of the centre point of the arc the parallel coordinate axis for X, Y, Z are address with letters _____.
4. Subroutines are also called as _____.
5. To activate sub program _____ code is used.

6. For coolant of _____code is used
7. The function of M00 is _____
8. The work is fed in the same direction as the path taken by the cutter teeth is called_____ milling
9. _____ is the simplest form of numerical control.
10. The sequence number of block is indicated by _____ letter
11. The function of G-40 is_____
12. In _____mode we can write or edit the program in VMC
13. JOG stands for _____
14. MDI stands for _____

Answers:

A. Fill in the blanks

Q.No.	Answers:	Q.No.	Answers:
1	'F'	6	M09
2	Fixed block	7	Program stop
3	I,J,K	8	Climb milling
4	Subprograms	9	Point to Point control
5	M98	10	N

B. Multiple choice questions: (1 Mark Each)

1. **The parallel axis for X,Y & Z in coordinate system for defining the arc valve are_**

   a.I, J & K   b. M, N & L

c. S, D & F   d. None of these

2. **M code for spindle reverse is :**

   a. M01   b. M08

   b. c. M04   d. M05

3. **Which of the following code is used for taking work offset:**

   a. G47-G42   b. G81-G83

   b. c. G54-G59   d. G90-G91.

4. **In part programming, interpolation is used for obtaining _____ trajectory.**

   a. helicoidal   b. pentagonal

   c. triangular   d. zig-zag

5. **An absolute NC system is one in which all position coordinates are referred to one fixed origin called the zero point.**

   a. True   b. False

c. None of these

19. **A turret mill has a ____ spindle and the table is moved ____ to the spindle axis to accomplish cutting.**

   a. Stationary, perpendicular   b. Moving, parallel

   c. Stationary, both perpendicular and parallel   d. Moving, perpendicular

7. **In the bed mill, the table moves ____ to the spindle's axis**

a. Only parallel   b. Only perpendicular

c. Both perpendicular and parallel   d. Inclined

8. **Following milling machine is used to cut gears**

   a. Horizontal milling machine   b. Vertical milling machine

   c. Both (A) and (B)   d. None of the above

9.**Following type of gear(s) can be cut on milling machine**

   a. Worm   b. Spiral bevel

   c. Spur   d. All of the above

10 **Jig borer are**

   a. Built to bore holes   b. Very light slot or face milling

   c. Typically bed mills with a long spindle throw   d. All of the above

11. Most CNC milling machines are

a. Computer controlled vertical mills b. Used in die sinking

c. Used in engraving applications   d. All of the above

12. Pocket milling is extensively used in

a. Aerospace industry   b. Shipyard industry

c. Both (A) and (B**)** d. Agriculture industry

13. In end mill cutter, flutes of the milling bit are

a. Deep helical grooves running up the cutter   **b**. Sharp blade along the edge

c. Holes   d. None of the above

14. In end mill cutter, chips are pulled up the

a. Flute   b. Tooth

c. Tip   d. Shank

15. End mills have cutting teeth

a. At one end   b. On the sides

c. Both (A) and (B)   d. None of the above

Answers:

B. Multiple choice questions

Q.No.	Answers:	Q.No.	Answers:
1	a. I, J & K	9	d. All of the above
2	c. M04	10	d. All of the above
3	c. G54-G59	11	d. All of the above
4	a. helicoidal	12	c. Both (A) and (B)
5	a. True	13	a. Deep helical grooves running up the cutter
6	c. Stationary, both perpendicular and parallel	14	a. Flute
7	b. Only perpendicular	15	.c. Both (A) and (**B**)
8	a. Horizontal milling machine		

C. Answer the following questions: (2 Marks Each)

1. What is the meaning of EOB? What it identifies

Ans: The meaning of EOB is End of Block. The symbol of EOB is Identifies the end of instruction block.

2. **Write the G-codes and their meaning which are used for cutter radius compensation**

   Ans: G-40 **---** Tool composition cancel

   G-41 --- Tool composition left

   G-42 --- Tool composition Right

3. **What is miscellaneous function?**

   Ans: The Miscellaneous function word is used to specify certain miscellaneous or auxiliary functions, which do not relate to the dimensional movements of the machine.

4. **How the machining along straight line is done**

   Ans: Machining along straight line is done using linear interpolation.

5. **What is the meaning of block in CNC part programming?**

   Ans: A collection of NC words is called Block & a block of words is complete instruction.

6. **What is the function of M-30?**

   Ans: The function of M-30 is programme stop and tape rewind

7. **Define Subroutines in programming?**

   Ans: Subroutines are also called subprogrammes, are a power full time saving technique. The subroutines provide the capability of programming certain fixed sequence of frequently repeated patterns.

8. **What is machine zero?**

   Ans: The machine zero point is at the origin of the coordinate measuring system of machine. The machine zero point is fixed and cannot be shifted.

9. **What is the advantage of cutter radius composition?**

   Ans: The difference in the programmed diameter of the cutter and the diameter of the actual cutter is accounted for by cutter radius compensation.

10. **What are the Zero point & Reference point? Why it is used?**

   Ans: On Every CNC machine, zero points and reference points are defined. The program for any component is developed relative to these points.

Part - B

I. Answer the following questions: (3 Marks Each)

1. Write the use of following codes

Ans: a. G00-Rapid traverse function   b.G71- Stock Removal in turning

G01- Linear interpolation G90- Absolute coordinate system
G02- Circular interpolation C/W   G91-Incremental coordinate system
G04-Dwell

2. **What is circular interpolation function? Which G-code is used for this function?**

   Ans: When the cutting tool is required to move along an arc, the instructions beused is called circular interpolation. G02-is used for Circular interpolation C/W & G03- Circular interpolation CCW.

3. **Define Work Zero.**

   Ans: Work piece zero or datum may be defined as a point, line or surface on the component drawing to which all the dimensions referenced.

4. **What is part programming?**

   Ans: Part program is a set of instructions, which instructs the machine tool about the processing steps to be performed for the manufacture of a component.

5. **Write the functions of following G-codes? G74 G75 G76**

   Ans: G74- slot milling   G75-Rectangular pocket (c/w)
    G76- Rectangular pocket (cc/w).

6. **Describe the Sub program function?**

   Ans: For sub program, call M98 code is used.
   The block is as follows M98 P__L__
   Where, P is Subprogram call   L is Number of pass to be cutted.

7. **Where the Do loop is used?**

   Ans: Do loop is used for repetitive programming in cases such as turning and milling operations where it is not possible to remove the entire material in a single pass and more than one cut have to be taken.

8. **Write blocks using give data.**

   Point 1 X.25.0 Y25.0 Point 2 X12.5 Y0 Point 3.X0 Y25.0 depth of cut is 0.5mm

Ans: Linear interpolation code is used in this block.
    N10 G01 X25.0 Y25.0 Z-0.5 F200;

N20 G01 X12.5 Y0;

N30 G01 X0 Y25.0;

9. What are the common techniques used for repetitive programming?

Ans: The common techniques used for repetitive programming are

  i) Subroutines   ii) Do loops   iii) canned cycles.

10. What are the work offset codes used in CNC milling machine?

Ans: G51 to G54 codes are used for work offset setting in CNC milling machine.

II. Answer the following questions: (5 Marks Each)
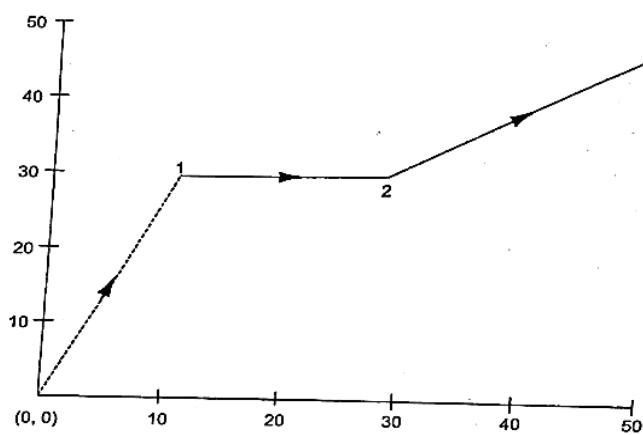
**1. Explain linear interpolation function with example by showing the block structure?**

Ans: Any machining along a straight line, including taper lines, is done using the linear interpolation function G01.The general format for writing an instruction block using G01 is N10_G01 X_Y_F_ EOB. This instruction block will move the cutting tool to a position specified by the co-ordinates in this block.

1) Starting point is (0, 0) and tool is 20mm above the job surface.

2) Machining is to be done along with points 1-2-3

3) Depth of grove is 3mm.

2. Explain the use of Zero Shift on CNC machines?

Ans: The zero shift facility is

Fig. 5.1

N5 G01 X 30.00 EOB	In linear. interpolation, the cutting tool moves to point 2 (writing G01 is optional).
N6 G01 X 50.00 Y 45.00 EOB	In linear interpolation, the cutting tool moves to point 3.
N7 G00 Z 20.00 EOB	Tool moves to a point 20 mm above the job surface at rapid feed rate.
N8 G00 X -10.00 Y 0.00 EOB	Move to point X-10.00 to clear the job for loading/ unloading
N9 M02 EOB	Programme end

available on CNC machines. This facility allows the machine tool zero point to be shifted to any position within the programmable area of the machines. The zero shift or datum shift facility allows the user to shift the machine zero to coincide with the work piece zero.

III. Answer the following questions: (8 Marks Each)

1. Write a CNC Programme to manufacture a square size 250X250mm thickness 50mm with corner radius R5. With sub programming method?

Ans:

SUB PROGRAM

O0011

N10 G91 EOB

N20 G01 Z-1.0 F50 EOB

N30 G01 X250 Y0 F500 EOB

N40 G01 X0 Y-250 EOB

N50 G01 X-250 Y0 EOB

N60 G01 X0 Y250 EOB

N70 M99 EOB

MAIN PROGRAM

O0022

N100 G90 G21 G17 G54 G40 EOB

N110 G00 X0 Y0 Z100 EOB

N120 G00 Z2 EOB

N130 MO3 S800 EOB

N140 M08 EOB

N150 G01 Z0.0 F50 EOB

N160 M98 P0011 L50 EOB

N170 G90 G00 Z100 EOB

N180 M05 EOB

N190 M09 EOB

N200 M30 EOB

2. Explain about following modes of CNC in panel board of CNC milling machine?

I) Editmode II) Single auto III) MDI mode IV) Jog Mode

Ans:I) Edit mode:

In this mode, you can able to write a new program file. Modify any program files, search a saved program file and delete program file. This mode has its own save memory, after writing any program the program will be automatically saved in the storage memory

II) Single Auto mode:

In this mode you can able to run a cycle or peogram by passing the CYCLE START button angain & again. I.e. If in the program there are 12 lines or blocks are there , then you have to press CYCLE START buttons for 12 times

III) MDI (Manual Data Input) Mode:

In this mode, you can also write the program and run it by pressing Cycle start. The only Disadvantage of this mode is that you can able to write maximum 6 blocks & after the execution of the program, the program is automatically deleted from machine memory.

IV) Jog Mode:

In this mode, you can also disturb the axis manually by the help of JOG table. It is controlled by feed rate over ride switch. If you press X, then X-axis will disturb, like this all the axis disturbed respectively.