CMR INSTITUTE OF TECHNOLOGY

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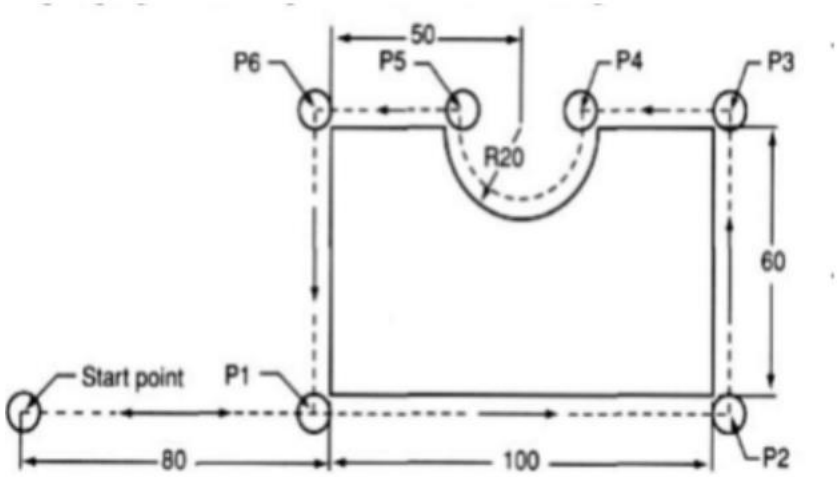
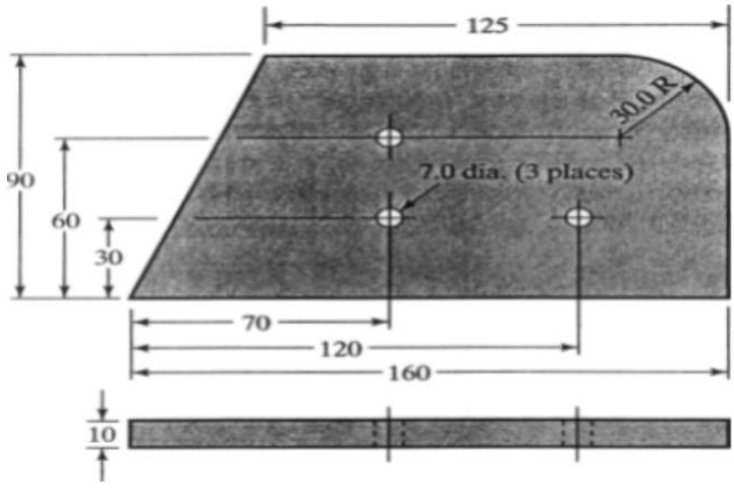
Internal Assesment Test - III

Sub:	ADDITIVE MANUFACTURING							Code:	17ME82
Date:	17/07/2021	Duration:	90 mins	Max Marks:	50	Sem:	VIII	Branch:	MECH (A&B)

Answer Any FIVE full Questions

		Marks	OBE	
			CO	RBT
1	Write a short note on the following 1. Manual part programming 2. Computer assisted part programming	[10]	CO3	L2
2	With neat block diagram explain CNC system and its components.	[10]	CO3	L2
3	Write part program for the following 	[10]	CO3	L3
4	Write computer aided part programming for the following milling operation 	[10]	CO3	L3
5	Explain the following 1. Explain with the neat sketch Wet chemical Synthesis of Nano materials 2. Explain with the neat sketch Sol gel Synthesis of Nano materials	[10]	CO1	L2
6	Explain the following 1. Scanning Probe Microscopy (SPM) - principles, Imaging Modes, Applications, Limitations. 2. Atomic Force Microscopy (AFM) – basic principles, instrumentation, operational modes, Applications, Limitations.	[10]	CO2	L2

CI **CCI** **HOD**

17/07/2021. ADM Lab - III.

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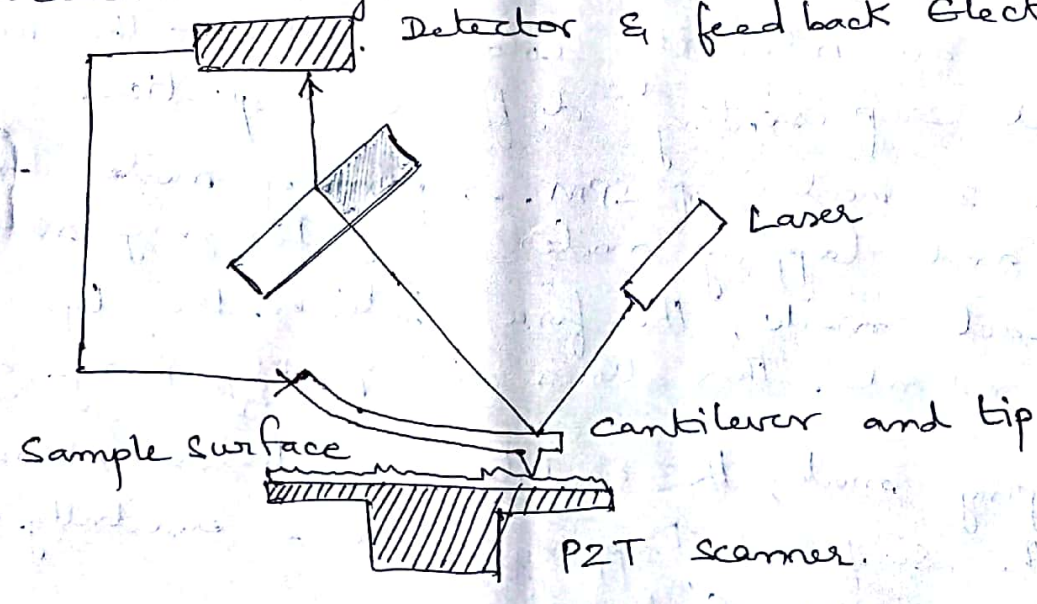
8th Sem A sec.

6. a) Explain. Scanning probe Microscopy (SPM).

Ans:- SPM gives researchers imaging tools for the future as these specialised microscopes provides high image magnification for observation of 3 dimensional shaped specimens. Scanning probe technology at the microspopic level is found in both academic and industrial laboratories today.



Working principle:-

→ SPMs are very powerful family of microscopes, sometimes with a resolution of less than a nanometer.

→ An Spm has a probe tip mounted on the head of a cantilever. The tip can be as sharp as a single atom. It can be moved precisely and accurately back and forth across the surface, even atom by atom.

→ When the tip is near the sample surface, the cantilever is deflected by a force. SPMs can measure deflections caused by many kinds of forces, including mechanical electrostatic and magnetic forces.

→ The distance of the deflection is measured by a laser that is reflected off the top of the cantilever and into a array of photodiodes.

→ SPMs can detect differences in height that are a fraction of a nanometer, about the diameter of a single atom. The tip is moved across the sample many times.

→ A computer combines the data to create an image. The images are inherently colourless. However the images are colourised representing different properties.

→ There are 2 modes of SPM. → primary modes are contact modes and tapping modes [Imaging modes]

→ In contact mode, the force between the tip and surface is kept constant. This allows to quickly image a surface.

→ In tapping mode, the cantilever oscillates, intermittently touching the surface. Tapping mode is essentially useful for imaging soft surface

* Advantages

1. It provides variety of specimen observation using same microscope
2. Faster and more efficient revealing specimen images with mirror effect and modification.

* Disadvantages.

1. The images are produced in black and white or grayscale which sometimes exaggerate actual size and shape
2. Computers are used to compensate for the exaggeration.

5. Explain Wet chemical synthesis of Nano materials.

Ans:- a) This is a bottom up approach, solution based processing routes used for synthesis of nano particles include precipitation of solids from supersaturated solution, homogenous liquid phase chemical reduction and ultrasonic decomposition of chemical precursors.

b) This process are attractive due to their simplicity Versatality and availability of low cost precursors.

c) Inorganic salt compounds used in wet chemical synthesis routes are more versatile and economical then alkoxides employed in sol gel process.

d) A typical example is the formation of nano crystalline titania powders via hydrolysis of $TiCl_4$ at lower temperatures

$$TiCl_4 + 2H_2O \longrightarrow TiO_2 + 4HCl.$$

e) Once the solution becomes saturated, crystallization of titania takes place either through homogenous or heterogenous nucleation, salt reduction is one of the most commonly adopted methods to generate the metal colloid particles

f) The process involves the dissolution of metal salts in aqeous or non aqeous environments followed by the reduction of metal cations to Zero-valent state. The nature of the metal salts determines the kind of reducing agent to be applied.

g) Metal nano particles can also be generated via ultrasonic and thermal decomposition of metal salts or chemical precursors. Power ultrasonic waves can stimulate certain novel chemical process due to formation of localised hot spots in liquid of extremly high temp

h) The main event in the process is nucleation, growth and collapse of cavitation bubbles formed in the liquid. The cooling achieved during the cavitation collapse is estimated to be greater than 2×10^9 K. It is called as sonochemical method.

i) Transition metal nanoparticles can be produced via sonication of their respective chemical precursors. Eg:- $Ni(CO)_4$ has been sonicated under argon atmosphere to obtain amorphous liquid

j) One disadvantage of sonification process is the difficulty in controlling the resulting particle size and distribution due to the aggelomeration of particles into a porous coral like microstructure.

Explain with neat sketch the sol gel synthesis of nano materials.

Ans:- The sol gel process involves the evolution of the inorganic networks through the formation of a colloidal suspension (sol) and gelation of the sol to form a network of a continous liquid phase (gel)

→ The starting material is processed to form a dispersible oxide and forms a sol in contact with water or dilute acid.

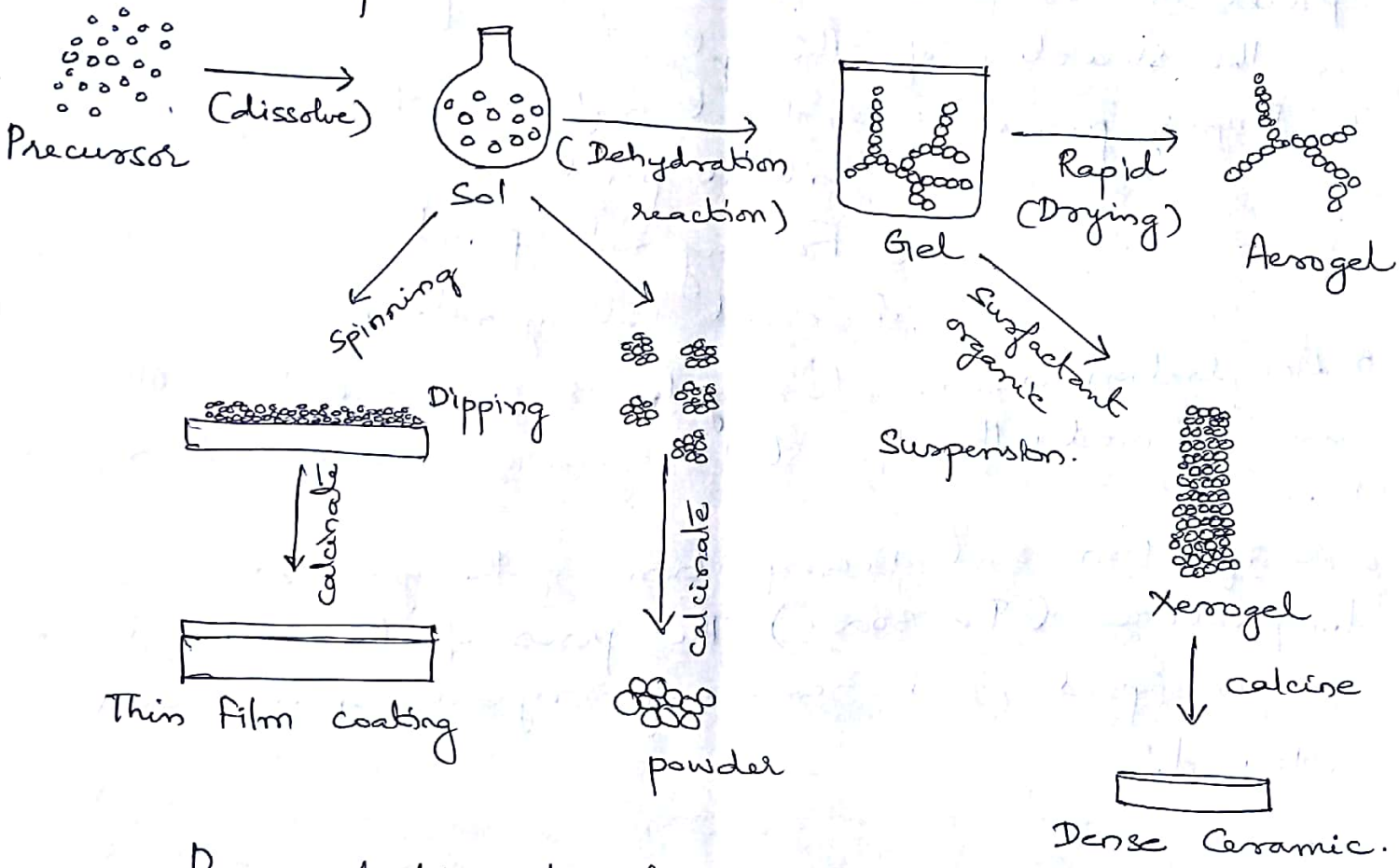
→ Removal of the liquid from the sol yeilds the gel, and the sol gel transition controls the particle size and shape

→ Calcination of the gel produces the oxide

→ sol gel processing refers to the hydrolysis of and condensation of the alkoxide based precursors.

→ Sol gel method of synthesising nanomaterials is very popular amongst chemists.

* The sol gel process can be characterised by series of distinct steps



Representation of Sol-gel process of synthesis of Nanomaterials.

1. Formation of different stable solutions of the alkoxide or solvated metal precursor.
2. Gelation Resulting from the formation of oxide or alcohol bridged network (the gel) by a polycondensation reaction results in a dramatic increase in the viscosity of the solution.
3. Aging the gel, during the poly condensation reaction continues until the gel transforms into a solid mass, accompanied by contraction of gel network and expulsion

of solvent from gel pores).

4. Drying of the gel is carried out when water and other volatile liquids are removed from the gel network. This process is complicated due to the fundamental changes in the structure of the gel.

The Drying process :- 1. constant rate period.
2. Critical point
3. Falling rate period
4. Second falling rate period.

5. Dehydration occurs during the surface bound M-OH groups are removed, thereby stabilizing the gel against rehydration.

6. Densification and Decomposition of the gels at high temperatures. (T > 800°C). The pores of the gel network are collapsed, and remaining organic species are volatized.

6.(b) Atomic force Microscope. (AFM).

Ans:- Working principle:-

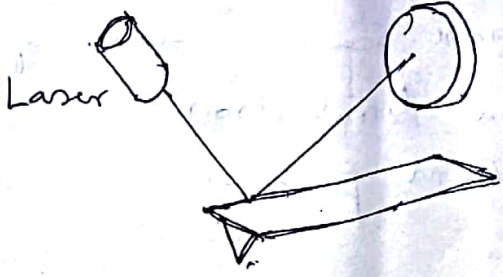
→ Sharp tip is raster scanned over a surface using a feed back loop to adjust parameters needed to image a surface. Atomic force microscope does not need a conducting sample, instead of using the quantum mechanic -al effect of tunneling, atomic forces are used to map the tip-sample interaction.

→ often referred to as scanning probe microscopy, there are atomic force microscopy techniques for almost any measurable force interaction.

* 2 Components in AFM:- Deflection and force Measurement

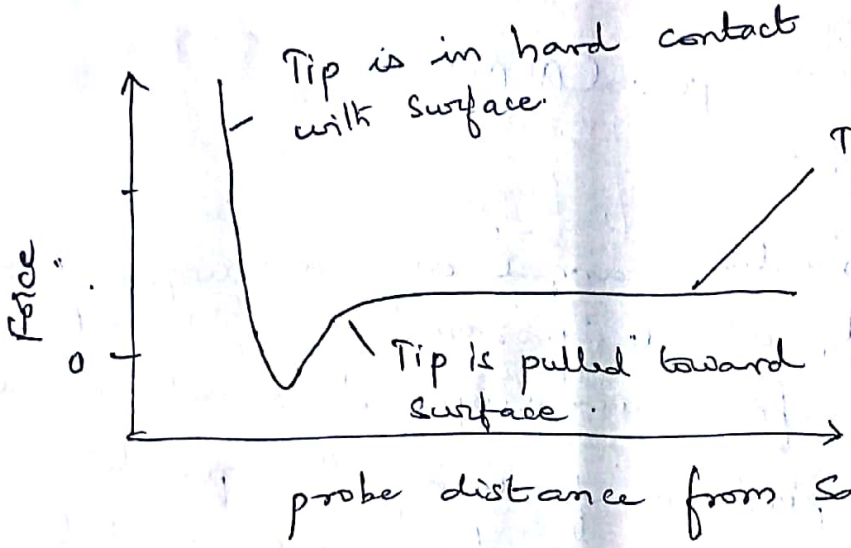
* AFM probe deflection.

AFM use a laser beam deflection system where a laser is reflected from the back of the AFM lever and onto a position sensitive detector.



* Measuring forces.

AFM relies on forces between tip and sample. These forces impact AFM imaging. The force is not measured directly but calculated by measuring the deflection of the lever.



* Feed back loop for AFM :-

Atomic force microscopy has a feedback loop using the laser deflection to control the force and tip position. As shown a laser is reflected from the back of a cantilever that includes the AFM tip. As the tip interacts with the surface, the laser position on the photo detector is used in the feed back loop to track the surface for imaging and measuring.

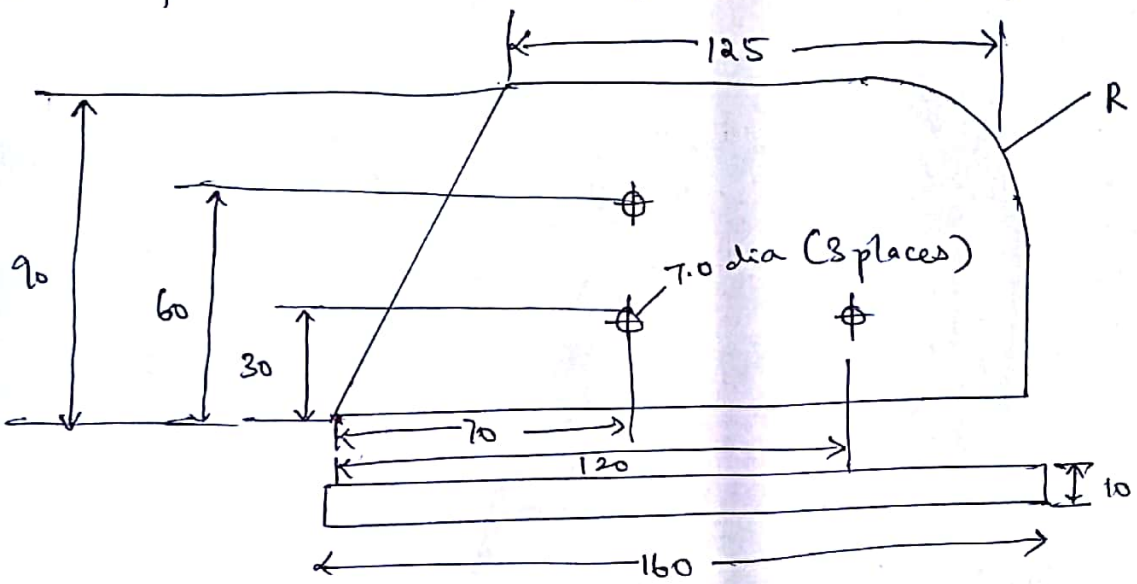
* Limitations :-

a) AFM can only image a max height on the order of 10-20 micrometers and max scanning area of 150 x 150 micrometer
b) Scanning speed is a limitation
c) Highly dependent on AFM probes.

* Applications.

a) It can image for biological processes.
b) Any sample of ceramic material, human cells. or individual molecules of DNA, Dispersion of metallic nanoparticles can be imaged.

(4.) Computer aided part programming for milling operation



Part programming code :-

N001 G21 G90 G92 X0 Y-050.0 Z010.0; Define origin of axes

N002 G00 Z-025.0 S1000 M03; Rapid to cutter depth, turn spindle on.

N003 G01 G94 G42 Y0 D05 F40; Engage part, start cutter offset

N004 G01 X160.0 Mill lower part edge

N005 G01 Y060.0; Mill Right straight edge.

N006 G17 G03 X130.0 Y090.0 R030.0; circular interpolation around arc

N007 G01 X035.0; Mill upper part edge.

N008 G01 X0 Y0; Mill left part edge.

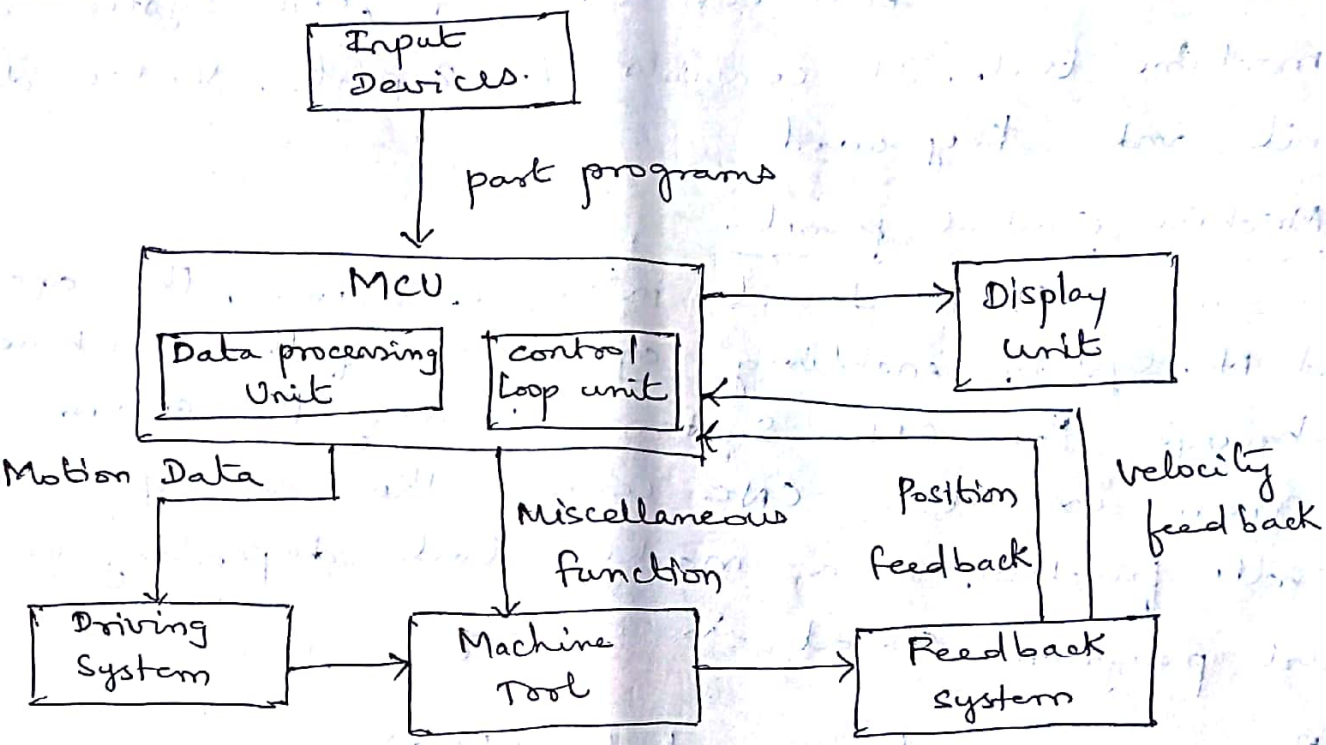
N009 G40 G00 X-040.0 M05; Rapid exit from part, cancel offset.

N010 G00 X0 Y-050.0; Rapid move to target point

N011 M30; End of program, stop machine

2. CNC System:-

Block diagram of CNC System.



The main components of CNC machine tool system are :-

a) Central processing unit.

→ Heart of CNC system.

→ Accepts the information stored in the memory as part program

→ Data is decoded and transformed into specific position control and velocity signals.

(b) Servo control unit

The position and velocity control signals, generated by CPU for the axis movement forms the input into the servo control unit. This unit generates suitable signals that are converted by the servo drive

(iii) Operator Control panel.

→ provides user interface to facilitate a two way communication between the user, CNC system and machine tool. It consists of 2 parts. Video display unit and keyboard.

(iv) Machine Control panel.

It is direct interface between the operator and NC system, enabling operation of the machine through the CNC System. During the ~~exam~~ program execution, CNC controls the axis of motion, spindle function on a machine tool depending on the parts program stored in memory

(v) Programmable logic controller (PLC)

A PLC matches to the NC of the machine. PLCs are now available with increased functions, more memory and larger input output capabilities.

(vi) Peripheral devices:-

These include sensor interface, provision for communication equipments, programming units, printer, tape reader interface etc...

① Write a short note on :-

a) Manual part programming

To prepare a part programming using manual method, the programmer writes the machining instructions on a special form called part programming manuscript. The instruction must be prepared in a very precise manner because the typist requires the NC tape directly from the manuscript. Manuscripts come in various forms depending on machine tool and tape format to be used.

The Manuscript is the list of relative tool and work piece locations. It includes other data, such as preparatory commands, miscellaneous instructions and speed / feed specifications.

Manual programming jobs can be divided into 2 categories. point to point jobs and contouring jobs. Except for complex work parts with many holes to be drilled, manual programming is ideally suited point to point applications.

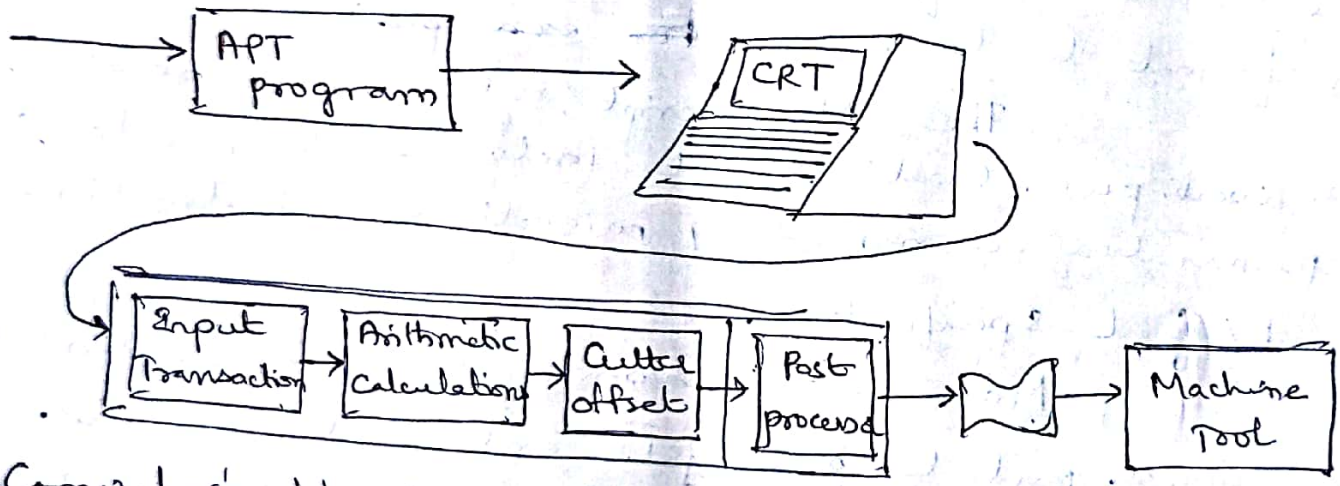
Manual programming can become time consuming applications for continous path control of the tool.

b) Computer Assisted part programming.

In the more complicated point to point jobs and in contouring applications, manual part programming becomes extremely tedious task and subject to errors. In these instances it is much more appropriate

to employ high speed digital computer to assist in the part programming process. Many part programming language systems have been developed to perform automatically most of the calculations which the programmer otherwise would be forced to do.

This saves time and results in a more accurate and more efficient part program.



Computer's job in Computer assisted part programming.