18ME701

Hall Ticket Number:

IV/IV B.Tech (Regular/Supplementary) DEGREE EXAMINATION

November,2022 | **Mechanical Engineering**

Seventh Semester | **Automation in Manufacturing**

Time: Three Hours | **Maximum:** 50 Marks

Answer Question No. 1 Compulsorily. (10X1 = 10 Marks)

*Answer **ANY ONE** question from each Unit.* (4X10=40 Marks)

1.	a)	Write any two functions of storage buffer?	CO1(BL1)	
	b)	Define Automation	CO1(BL1)	
	c)	Write the features of CNC	CO2(BL1)	
	d)	What are the benefits of adaptive control?	CO2(BL1)	
	e)	Name the Acronym of APT	CO2(BL1)	
	f)	List out the demerits of Automation in manufacturing	CO1(BL1)	
	g)	Define group technology	CO3(BL1)	
	h)	Write any two benefits of CAPP	CO3(BL1)	
	i)	Define flexible manufacturing system	CO4(BL1)	
	j)	List out the inspection methods in Automation in manufacturing	CO4(BL1)	
		Unit - I		
2.	a)	Differentiate programmable and flexible automation	CO1(BL4)	6M
	b)	What are the various situations where automation is preferred over manual labor?	CO1(BL1)	4M
		(OR)		
3.	a)	What are the three configurations of automated flow lines?	CO1(BL1)	6M
	b)	Explain any four reasons, why storage buffers are used on automated production lines?	CO1(BL2)	4M
		Unit - II		
4.	a)	Categorize the interpolation methods used in CNC and explain with an example.	CO2(BL4)	5M
	b)	Explain the MCU of CNC machines.	CO2(BL2)	5M
		(OR)		
5.	a)	Discuss about NC coding and part programming in numerical control systems.	CO2(BL2)	5M
	b)	Explain the part programming of NC machine tools using APT Language.	CO2(BL2)	5M
		Unit - III		
6.	a)	Write a short note on OPITZ and MICLASS coding systems.	CO3(BL3)	4M
	b)	Explain Production flow analysis to make part families clearly.	CO3(BL2)	6M
		(OR)		
7.	a)	Briefly explain how the computer tasks in Computer assisted part programming.	CO3(BL2)	4M
	b)	Discuss about the retrieval CAPP system and how it integrated with automated manufacturing systems.	CO3(BL2)	6M
		Unit - IV		
8.	a)	With a block diagram explain components structure of FMS and their functions.	CO4(BL2)	5M
	b)	Explain how the CIM reduces the human effort by conventional manufacturing.	CO4(BL2)	5M
		(OR)		
9.	a)	Discuss briefly about the construction of Coordinate measuring machine.	CO4(BL2)	5M
	b)	Illustrate the working of machine vision with a neat sketch.	CO4(BL3)	5M

Detailed Scheme of Evaluation

1. **a) Write any two functions of storage buffer?**
    a. In principle, buffer storage serves as a "parking area" for items until they are needed for production or orders.
    b. In linear processes, these parking areas are located between two different sequential process steps and represent a temporary function

b) Define Automation

Automation is a technology concerned with the application of mechanical, electronic and computer-based systems to operate and control systems.

c) Write the features of CNC

a. Flexible And Versatile
b. High Machining Accuracy
c. High Production Efficiency
d. It Can Process Complex Shapes
e. Reduce The Labor Intensity of The Operator
f. Complex Shapes of Machined Parts
g. The Structure of Workpieces that are difficult to Process on Ordinary Milling Machines

d) What are the benefits of adaptive control?

- Adaptive control is needed to protect the tool, the workpiece, and the machine from damage caused by malfunctions or by unexpected changes in machine behavior.
- Adaptive control is also a significant factor in developing unmanned machining techniques

e) Name the Acronym of APT

APT stands for Automatically Programmed Tool

f) List out the demerits of Automation in manufacturing

Disadvantages:

- High capital expenditure required to invest in automation,
- A higher level of maintenance needed than with a manually operated machine,
- Lower degree of flexibility in terms of the possible products as compared with a manual system

g) Define group technology

Group technology is a manufacturing philosophy or principle whose basic concept is to identify and bring together related or similar parts and processes, to take advantage of the similarities which exist, during all stages of design and manufacture.

h) Write any two benefits of CAPP

- CAPP can give more complete and detailed process plans.
- Process planning and production lead time is reduced.
- CAPP can give faster responses to engineering changes.
- Greater process plan consistency is ensured.

i) Define flexible manufacturing system

A flexible manufacturing system (FMS) is a production method that is designed to easily adapt to changes in the type and quantity of the product being manufactured. Machines and computerized systems can be configured to manufacture a variety of parts and handle changing levels of production

j) List out the inspection methods in Automation in manufacturing

- Manual inspection
- Automated inspection

UNIT - I

2. a) Differentiate programmable and flexible automation **6M**

Programmable – this automation method is designed with the capability to alter the sequence of operations. This is necessary when you need to make accommodation for different product configurations. This automation is ideal for batch productions.

Flexible Automation/ Soft automation – this production method is considered an extension of programmable automation. When working with flexible automation systems, you can make various parts without significant downtime from changeovers. When using these systems, you do not lose production time when reprogramming and altering physical setups.

b) What are the various situations where automation is preferred over manual labor? **4M**

(1) When the technology for the operation of manufacture is too difficult due to various reasons like cost of automation, location and layout of the plant, requirement of manual dexterity and necessity of hand-eye coordination.
(2) When the life of the product is short, the product should be introduced into the market in a very short time. So, fabrication of manual tooling equipment takes less time to fabricate automated tooling equipment.
(3) When the customer wants to customize their product.
(4) In order to cope with changing demand trends.
(5) When a product is introduced in the market, there may be risk of failure of the product and may live in the market for a short period of time. Manual labor may be preferred instead of large equipment cost.

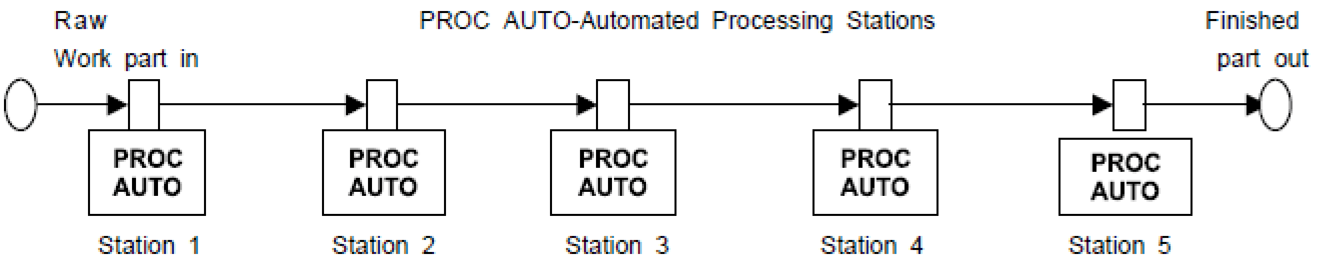
(OR)

3. a) What are the three configurations of automated flow lines? **6M**

Configurations of automated flow line.

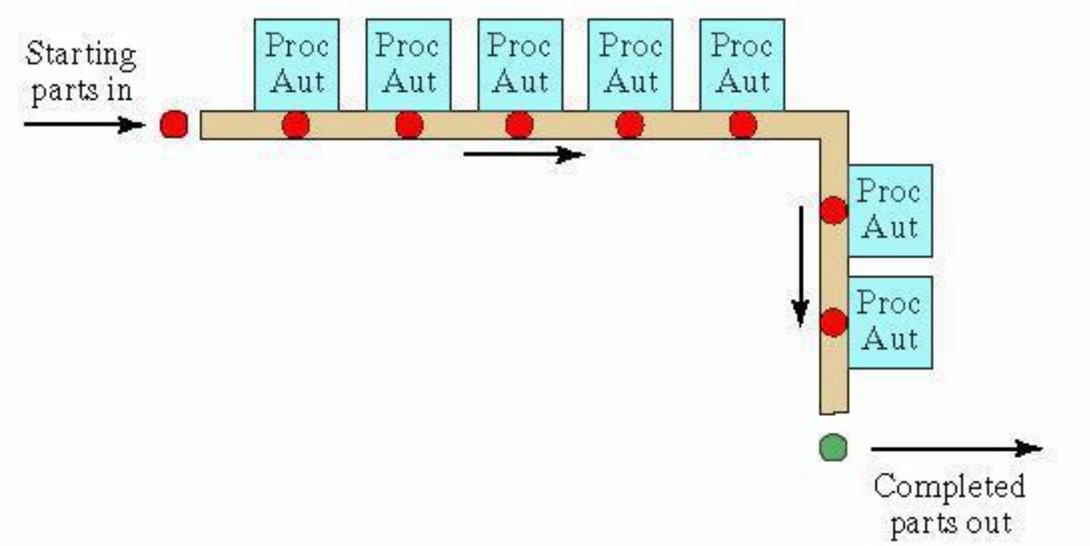
<u>1) In-line type</u>

The in-line configuration consists of a sequence of workstations in a more-or-less straight-line arrangement



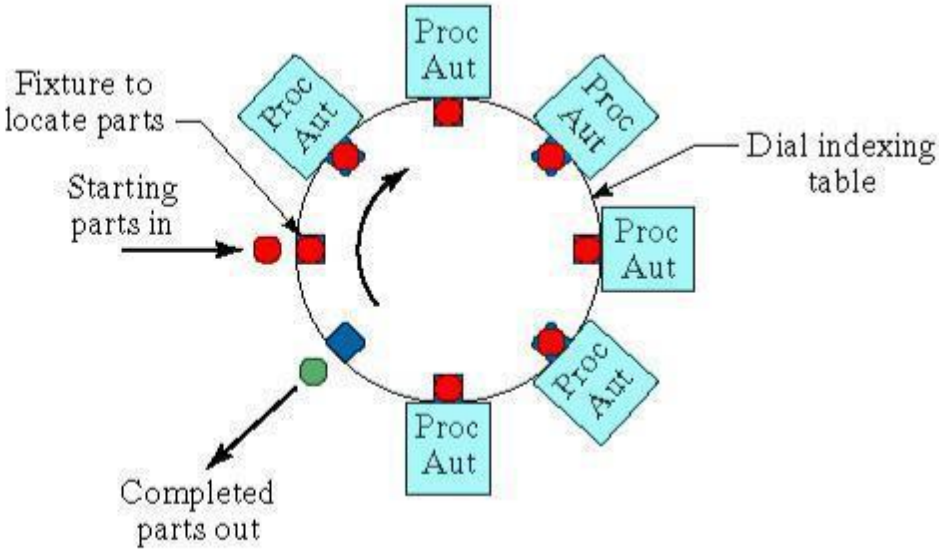
<u>2) Segmented In-Line Type</u>

The segmented in-line configuration consists of two or more straight-line arrangement which are usually perpendicular to each other with L-Shaped or U-shaped or Rectangular



3) Rotary type

In the rotary configuration, the work parts are indexed around a circular table or dial. The workstations are stationary and usually located around the outside periphery of the dial. The parts ride on the rotating table and are registered or positioned, in turn, at each station for its processing or assembly operation. This type of equipment is often referred to as an indexing machine or dial index machine



b) Explain any four reasons why storage buffers are used on automated production lines? 4M

Reasons for using storage buffers:

i. To reduce effect of station breakdowns
ii. To provide a bank of parts to supply the line
iii. To provide a place to put the output of the line
iv. To allow curing time or other required delay
v. To smooth cycle time variations
vi. To store parts between stages with different production rates

UNIT - II

4. a) Categorize the interpolation methods used in CNC and explain with an example. 5M

Interpolation, which is necessary for any type of programming, consists of generating data points between given coordinate axis positions. Within the Machine Control Unit (MCU), a device called an interpolator causes the drives to move simultaneously from the start to the end of the command. The interpolator is either an electronic hardware device for a NC system, or a software program for a CNC system.

An interpolator provides two functions:

- It calculates individual axis velocities to drive the tool along the programmed path at the given feed rate.

- It generates thousands of intermediate coordinate points along the programmed path between the start point and the end point of the cut.

  During positioning, all programmed axes move simultaneously at the specified feed rates until each axis has reached its destination. All drives start together, but without interpolator individual destinations are reached successively according to the path traveled. However, an interpolator coordinates these axis motions in such a way that the programmed path is constantly maintained from the beginning to the end of the movement.

- Linear and circular interpolation are most used in CNC programming applications

- Linear interpolation is used for straight-line machining between two points.

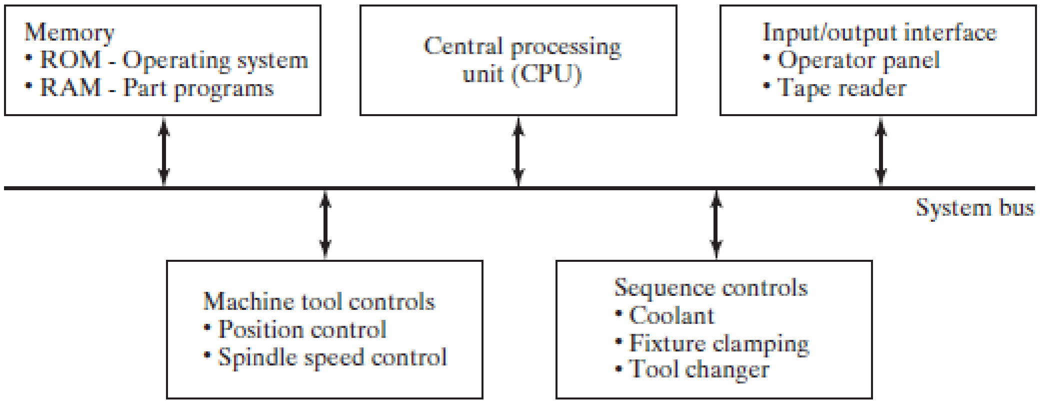
- Circular interpolation is used for circles and arcs.

- Helical interpolation, used for threads and helical forms, is available on many CNC machines.

- Parabolic and cubic interpolation are used by industries that manufacture parts having complex shape such as aerospace parts

b) Explain the MCU of CNC machines. **5M**

The MCU is the hardware that distinguishes CNC from conventional NC. The MCU consists of the following components and subsystems:
(1) central processing unit,
(2) memory,
(3) I/O interface
(4) controls for machine tool axes and spindle speed, and
(5) sequence controls for other machine tool functions.
These subsystems are interconnected by means of a system bus, which communicates data and signals among the components of the network.



Central Processing Unit. The central processing unit (CPU) is the brain of the MCU. It manages the other components in the MCU based on software contained in main memory. The CPU can be divided into three sections: (1) control section, (2) arithmetic logic unit, and (3) immediate access memory. The control section retrieves commands and data from memory and generates signals to activate other components in the MCU. In short, it sequences, coordinates, and regulates the activities of the MCU computer.

Memory: The immediate access memory in the CPU is not intended for storing CNC software. A much greater storage capacity is required for the various programs and data needed to operate the CNC system. As with most other computer systems, CNC memory can be divided into two categories: (1) main memory and (2) secondary memory. Main memory consists of ROM (read-only memory) and RAM (random access memory) devices.

Input/Output Interface. The I/O interface provides communication between the various components of the CNC system, other computer systems, and the machine operator. As its name suggests, the I/O interface transmits and receives data and signals to and from external devices

Controls for Machine Tool Axes and Spindle Speed: These are hardware components that control the position and velocity (feed rate) of each machine axis as well as the rotational speed of the machine tool spindle.

(OR)

5. a) Discuss about NC coding and part programming in numerical control systems. 5M

In manual part programming, the programmer prepares the NC code using a low-level machine language. The coding system is based on binary numbers. This coding is the low-level machine language that can be understood by the MCU. The statements in these respective programs are converted to this basic code. NC uses a combination of the binary and decimal number systems, called the binary-coded decimal (BCD) system. In this coding scheme, each of the ten digits (0–9) in the decimal system is coded as a four-digit binary number, and these binary numbers are added in sequence as in the decimal number system.

In addition to numerical values, the NC coding system must also provide for alphabetical characters and other symbols. Eight binary digits are used to represent all the characters required for NC part programming.

b) Explain the part programming of NC machine tools using APT Language. 5M

APT stands for Automatically Programmed Tool. It is a language that defines the tool path with respect to the part geometry, and often forms the basis for post-processor generated NC files.

The APT language consists of four types of statements. Geometry statements will be used to specify the elemental features defining the part shape. Motion statements are used to specify the path taken by the tool. Post-processor statements control the machinery, controlling coolants as well as the feeds and speeds. Auxiliary statements complete the picture, specifying the part, required tools, etc. The following sections describe each of the APT statements.

1. Geometry Statements

All geometric elements must be defined before tool motion may be programmed. Geometry statements associate a symbol with a description of the geometric element and its parameters. The general form for a geometry statement is:

symbol = geometric type/parametric description

The symbol consists of up to six alpha-numeric characters, containing at least one alpha character, and avoiding APT reserved words. The symbols provide a means to name the geometric features. The equals sign separates the symbol from the geometric type.

The geometric type describes these features. POINT, LINE, PLANE, and CIRCLE are valid APT geometric types. The forward slash character separates the geometric type from the parametric description of the feature.

The parametric description specifies the location and size of the feature. It may include dimensional data, positional data, and other APT words relating to the feature to previously defined APT symbols. The APT language provides a rich means to specify the geometry, as is evidenced by the following examples.

To specify a point:

P0 = POINT/1.0, 1.2, 1.3 specifies a point at XYZ coordinates 1.0, 1.2, and 1.3, respectively.

P1 = POINT/INTOF L1, L2 specifies a point at the intersection of lines L1 and L2, which must have been defined prior to the statement.

To specify a plane:
PL0 = PLANE/P0, P1, P2 specifies a plane through three, non-colinear, previously defined points.
PL1 = PLANE/P3, PARLEL, PL0 specifies a plane through a point P3 parallel to a plane PL0.
To specify a circle:
C0 = CIRCLE/CENTER, P0, RADIUS, 1.0 specifies a circle of radius 1 from a center point of P0.
Lines and planes extend infinitely. Circles are always complete. The same geometry may be defined only once and may not have more than one symbol.

2. Motion Statements

The format for motion commands follows the pattern:
motion/description
The initial motion starts from a home position, and takes the form:
FROM/P0 or FROM/ 0.0, 1.0, 2.0
The FROM motion statement occurs only once for each set of a motion type, at the start of the set of motions.
Contouring motion – is the most common motion used in APT programming, and these statements specify the tool path continuously throughout the motion. They make use of three surfaces: (a) drive; (b) check; and (c) part surfaces.
Drive surfaces represent the surface along which the vertical edges of the tool will follow. Part surfaces specify the surfaces the tip of the tool will follow. And check surfaces describe where the tool will come to rest after it has completed the motion of the current step. There are four locations for the tool to stop with respect to a check surface. These four possibilities each have their own modifier words.
The TO modifier stops the tool when the first surface of the tool would come into contact with the check surface. The ON modifier stops the tool where the center point of the tool would come into contact with the check surface. The PAST modifier stops the tool where the last surface of the tool would contact the check surface. And the TANTO modifier stops the tool at the point of circular tangency with the edge of the tool.
The initial contouring motion statement is the GO/TO, which defines the initial drive, part and check surfaces. It takes the form:
GO/TO, drive surface, TO, part surface, TO, check surface
An example would be:
GO/TO, L1, TO, PL1, TO, L2 specifying that the tool should use line L1 as the drive surface, plane P1 as the part surface, and line L2 as the check surface.
Note: the GOTO and the GO/TO statements are not the same. The former specifies point to point motion (see below), and the latter initiates contouring motion.
Continuing contouring motion statements are given from the vantage point of a person sitting on the top of the tool. The motion words are: (a) GOLFT; (b) GORGT; (c) GOFWD; (d) GOBACK; (e) GOUP; and (f) GODOWN. The sense of these words depends on the direction the tool has been coming from, and is depicted in Figure 2:

Figure 1. Motion Continuation Statements
Point to point motion – may be specified as absolute, or as incremental (relative to the last point visited). An example of absolute, point to point motion is:
GOTO/P0
An example of incremental, point to point motion is:
GODLTA/1.0, 2.0, 3.0
Point to point motion is useful in peck drilling or similar operations, since the motion path in-between the points is unimportant.

3. Post-Processor Statements

These statements provide processing parameters to the post-processor program. Typical programs will require parameters for feeds, speed, and other tool/spindle/machine controls. Examples:
SPINDL/600 specifies the spindle to be 600 rpm.
FEDRAT/6.0 specifies a feed rate of 6 inches per minute.
TURRET/T2 specifies loading tool # 2 in the turret.
A final post-processor statement must specify to the post-processor program what type of machine is intended for the final NC code, and the specific controller to generate the code for. An example is:
MACHIN/MILL,2 specifies a mill machine type, and controller type 2

4. Auxiliary Statements

These statements complete the APT programming language and include the FINI statement to mark the end of the program as well as statements to define the width of the tool. An example of the latter is:
CUTTER/0.25 specifies a quarter-inch cutter diameter.
The computer would then know to calculate a 0.125-inch offset to accommodate the cutter diameter in computing

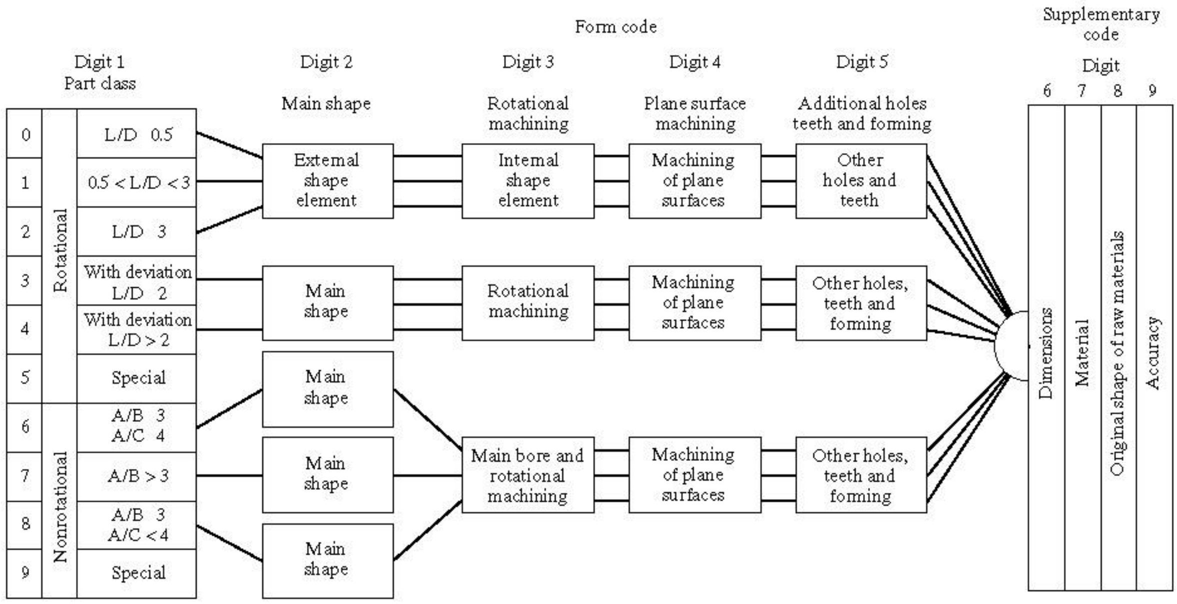
UNIT - III

6. a) Write a short note on OPITZ and MICLASS coding systems. 4M

This system was developed by H. OPITZ of the University of Aachen in Germany. It represents one of the pioneering efforts in group technology and is probably the best known, if not the most frequently used, of the parts classification and coding systems. It is intended for machined parts. The OPITZ coding scheme uses the following digit sequence:

12345 6789 ABCD

The basic code consists of **nine digits**, which can be extended by adding four more digits. The first nine are intended to convey both design and manufacturing data. The interpretation of the first nine digits is defined in Figure. The **first five** digits, 12345, are called the ***form code***. It describes the primary design attributes of the part, such as external shape (e.g., rotational vs. rectangular) and machined features (e.g., holes, threads, gear teeth, etc.)
The next **four digits**, 6789, constitute the ***supplementary code***, which indicates some of the attributes that would be of use in manufacturing (e.g., dimensions, work material, starting shape, and accuracy). The extra four digits, ABCD, are referred to as the ***secondary code*** and are intended to identify the production operation type and sequence. The secondary code can be designed by the user firm to serve its own needs.



b) Explain Production flow analysis to make part families clearly 6M

Product flow analysis (PFA) is a method for identifying part families and associated machine groupings that use the information contained on production route sheets rather than on part drawings. Work parts with identical or similar routings are classified into part families. These families can then be used to form logical machine cells in a group technology layout. Since PFA uses manufacturing data rather than design data to identify part families, it can overcome two possible anomalies that can occur in parts classification and coding. ***First,*** parts whose basic geometries are quite different may nevertheless require similar or even identical process routings. ***Second,*** parts whose geometries are quite similar may nevertheless require process routings that are quite different.
The procedure in production flow analysis must begin by defining the scope of the study, which means deciding on the population of parts to be analyzed. Should all of the parts in the shop be Included in the study, or should a representative sample be selected for analysis! Once this decision is made, then the procedure in PFA consists of the following steps:
1. ***Data collection:*** The minimum data needed in the analysis are the part number and operation sequence, which is contained in shop documents called route sheets or operation sheets or some similar name. Each operation is usually associated with a machine, so determining the operation sequence also determines the machine sequence. Additional

data, such as lot size, time standards, and annual demand might be useful for designing machine cells of the required production capacity.

2. Sortation of process routings: In this step, the parts are arranged into groups according to the similarity of their process routings. To facilitate this step, all operations or machines included in the shop are reduced to code numbers. For each part, the operation codes are listed in the order in which they are performed. A sortation procedure is then used to arrange parts into "packs," which are groups of parts with identical routings. Some packs may contain only one part number, indicating the uniqueness of the processing of that part. Other packs will contain many parts, and these will constitute a part family.

3. PFA chart: The processes used for each pack are then displayed in a PFA chart.

4. Cluster analysis: From the pattern of data in the PFA chart, related groupings are identified and rearranged into a new pattern that brings together packs with similar machine sequences.

(OR)

7. a) Briefly explain how the computer tasks in Computer assisted part programming. 4M

Computer Tasks in Computer-Assisted Part Programming: The computer's role in computer-assisted part programming consists of the following steps, performed more or less in the sequence given:

(1) input translation,

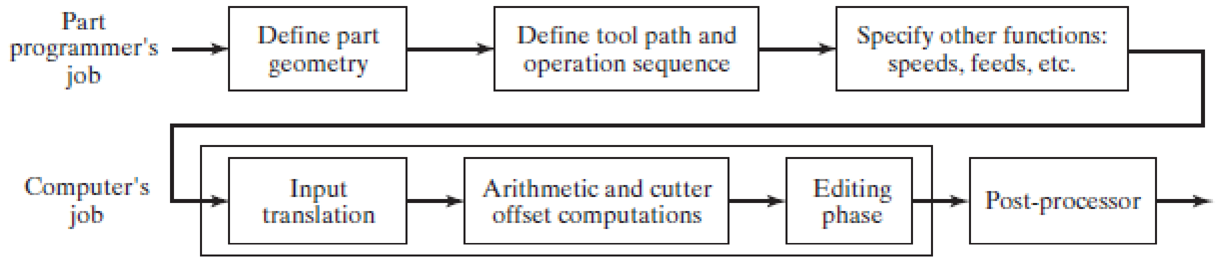
(2) arithmetic and cutter offset computations,

(3) editing, and

(4) post-processing.

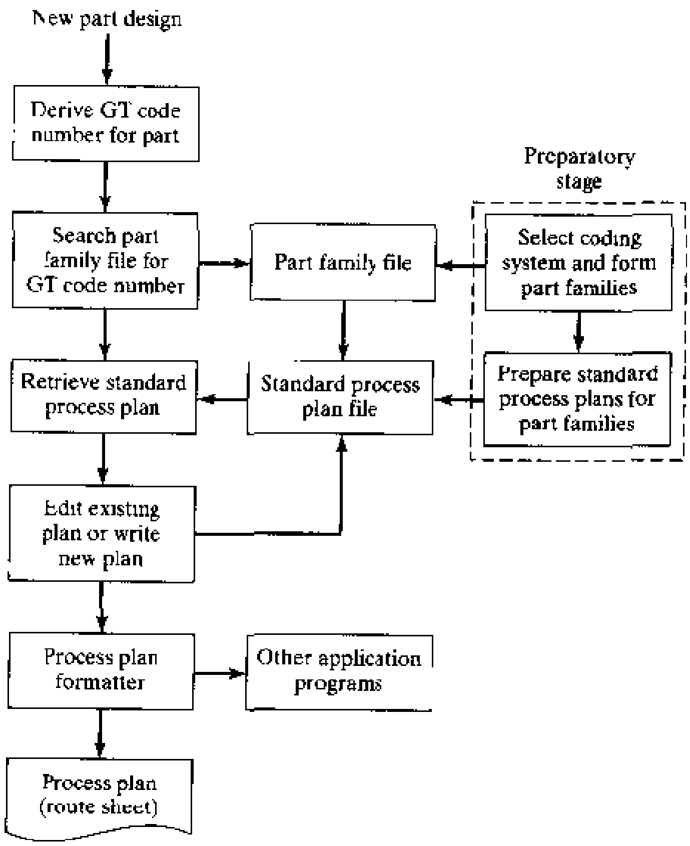
The first three steps are carried out under the supervision of the language processing program. For example, the APT language uses a processor designed to interpret and process the words, symbols, and numbers written in APT. Other high-level languages require their own processors, but they work similarly to APT. The fourth step, post-processing, requires a separate computer program.

The part programmer enters the program using APT or some other high-level part programming language. The input translation module converts the coded instructions contained in the program into computer-usable form, preparatory to further processing. In APT, input translation accomplishes the following tasks: (1) syntax check of the input code to identify errors in format, punctuation, spelling, and statement sequence; (2) assigning a sequence number to each APT statement in the program; (3) converting geometry Elements into a suitable form for computer processing; and (4) generating an intermediate file called PROFIL that is utilized in subsequent arithmetic calculations.



b) Discuss about the retrieval CAPP system and how it integrated with automated manufacturing systems. 6M

A *retrieval CAPP* system, also called a *variant CAPP* system, is based on the principles of group technology (GT) and parts classification and coding. In this type of CAPP, a standard process plan (route sheet) is stored in computer files for each part code number. The standard route sheets are based on current part routings in use in the factory or on an ideal process plan that has been prepared for each family. It should be noted that the development of the database of these process plans requires substantial effort. Before the system can be used for process planning, a significant amount of information must be compiled and entered into the CAPP data files. This is called as the "preparatory phase:' It consists of the following steps: (1) selecting an appropriate classification and coding scheme for the company, (2) forming part families for the parts produced by the company; and (3) preparing standard process plans for the part families. It should be mentioned that steps (2) and (3) continue as new parts are designed and added to the company's design database.



UNIT - IV

8. a) With a block diagram explain components structure of FMS and their functions. 5M

A flexible manufacturing system (FMS) is a highly automated CIM system. Regardless of its components, any FMS has as its goal making the plant more flexible—that is, achieving the ability to quickly produce wide varieties of products using the same equipment. There are several basic components of an FMS: (1) workstations, (2) material handling and storage system, and (3) computer control system. In addition, even though an FMS is highly automated, (4) people are required to manage and operate the system.

Workstations: The processing or assembly equipment used in an FMC or FMS depends on the type of work accomplished by the system. In one designed for machining operations, the principal types of processing station are CNC machine tools. However, the FMS concept is applicable to other processes as well.

Load/Unload Stations: The load/unload station is the physical interface between the FMS and the rest of the factory. It is where raw work parts enter the system and finished parts exit the system. Loading and unloading can be accomplished either manually (the most common method) or by automated handling systems.

Machining Stations: The most common applications of flexible manufacturing systems are machining operations. The workstations used in these systems are therefore predominantly CNC machine tools. Most common are CNC machining centers, which possess features that make them compatible with the FMS

Assembly: Some flexible manufacturing systems are designed to perform assembly operations. Flexible automated assembly systems are gradually replacing manual labor in the assembly of products typically made in batches. Industrial robots are often used as the automated workstations in these flexible assembly systems.

Other Stations and Equipment: Inspection can be incorporated into a flexible manufacturing system, either by including an inspection operation at a processing workstation or by including a station specifically designed for inspection.

b) Explain how the CIM reduces the human effort by conventional manufacturing. 5M

CIM reduces the human component of manufacturing and thereby relieves the process of its slow, expensive and error-prone component. CIM stands for a holistic and methodological approach to the activities of the manufacturing enterprise in order to achieve vast improvement in its performance.

This methodological approach is applied to all activities from the design of the product to customer support in an integrated way, using various methods, means and techniques in order to achieve production improvement, cost reduction, fulfillment of scheduled delivery dates, quality improvement and total flexibility in the manufacturing system. CIM requires all those associated with a company to involve totally in the process of product development and manufacture. In such a holistic approach, economic, social and human aspects have the same importance as technical aspects. CIM also encompasses the whole lot of enabling technologies including total quality management, business process reengineering, concurrent engineering, workflow automation, enterprise resource planning and flexible manufacturing.

(OR)

9. a) Discuss briefly about the construction of Coordinate measuring machine. 5M

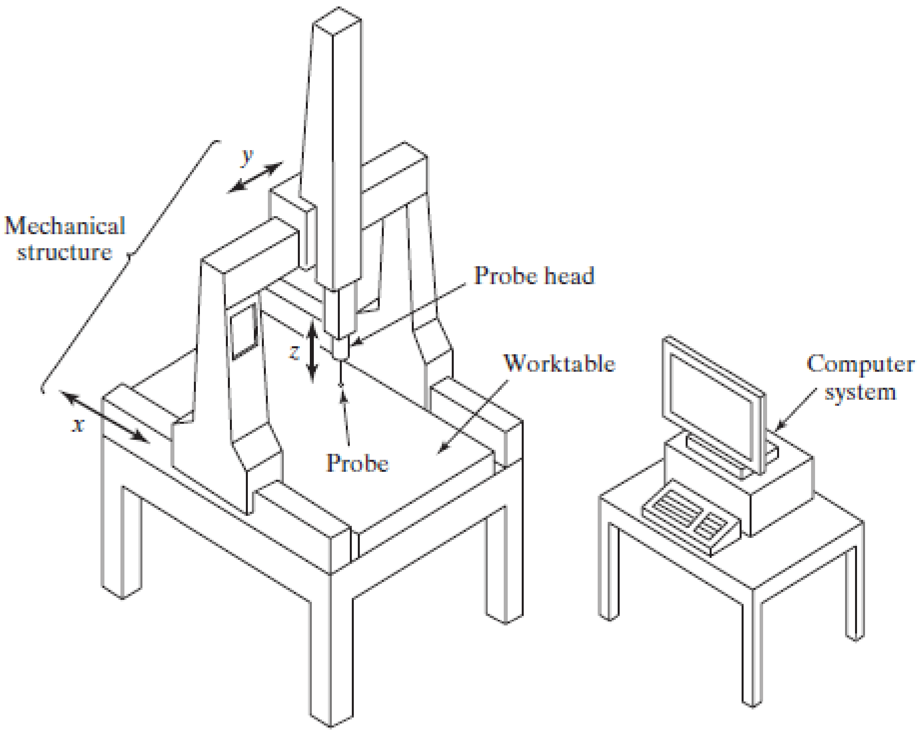
A coordinate measuring machine (CMM) is an electromechanical system designed to perform coordinate metrology. It has a contact probe that can be positioned in three dimensions relative to the surfaces of a work part. The *x*, *y*, and *z* coordinates of the probe can be accurately and precisely recorded to obtain dimensional data about the part geometry.

To accomplish measurements in three-dimensional space, the basic CMM consists of the following components:

- Probe head and probe to contact the work part surfaces
- Mechanical structure that provides motion of the probe in three Cartesian axes and
- displacement transducers to measure the coordinate values of each axis.

In addition, many CMMs include the following:

- Drive system and control unit to move each of the three axes
- Digital computer system with application software.



The two basic components of the CMM are its probe and its mechanical structure.

Probe. The contact probe indicates when contact has been made with the part surface during measurement. The tip of the probe is usually a ruby ball. Ruby is a form of corundum (aluminum oxide), whose desirable properties in this application include high hardness for wear resistance and low density for minimum inertia

Mechanical Structure. There are various physical configurations for achieving the motion of the probe, each with advantages and disadvantages. Nearly all CMMs have a mechanical structure that fits into one of the following six types:

1. Cantilever
2. Moving bridge
3. Fixed bridge
4. Horizontal arm
5. Gantry
6. Column

b) Illustrate the working of machine vision with a neat sketch. 5M

Machine vision consists of the acquisition of image data, followed by the processing and interpretation of these data by computer for some industrial application. Machine vision is a growing technology, with its principal applications in automated inspection and robot guidance.

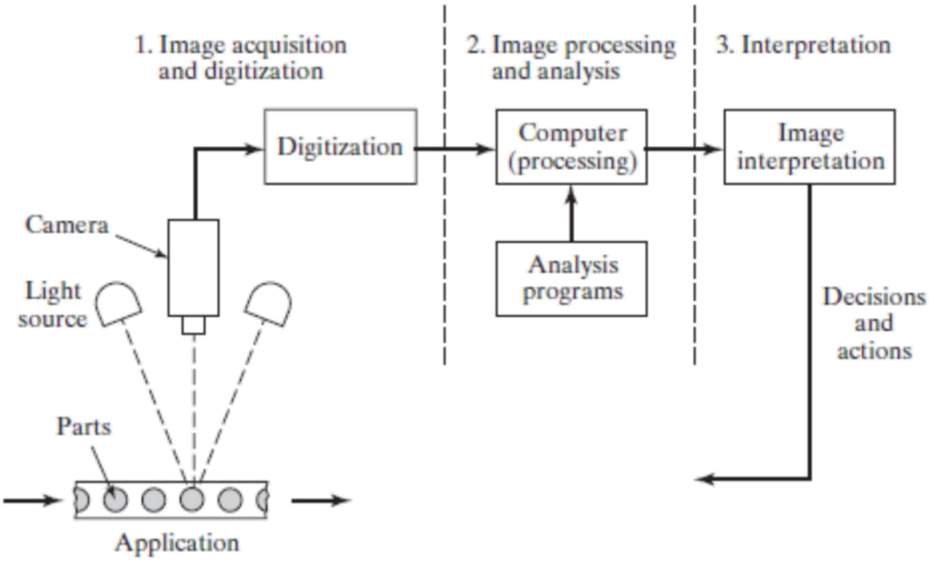


Image acquisition and digitization is accomplished using a digital camera and a digitizing system to store the image data for subsequent analysis. The camera is focused on the subject of interest, and an image is obtained by dividing the viewing area into a matrix of discrete picture elements (called pixels), in which each element has a value that is proportional to the light intensity of that portion of the scene. The intensity value for each pixel is converted into its equivalent digital value by an ADC

Image Processing and Analysis: The second function in the operation of a machine vision system is image processing and analysis. Several techniques have been developed for analyzing the image data in a machine vision system. One category of techniques in image processing and analysis, called *segmentation*, is intended to define, and separate regions of interest within the image. Two of the common segmentation techniques are thresholding and edge detection.

Interpretation: For any given application, the image must be interpreted based on the extracted features. The interpretation function is usually concerned with recognizing the object, a task called *object recognition* or *pattern recognition*. The objective in this task is to identify the object in the image by comparing it with predefined models or standard values. Two commonly used interpretation techniques are template matching and feature weighting.

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