Model Question Paper

CBCS Scheme

USN | | | | | | | | | | |

Seventh Semester B.E. Degree Examination

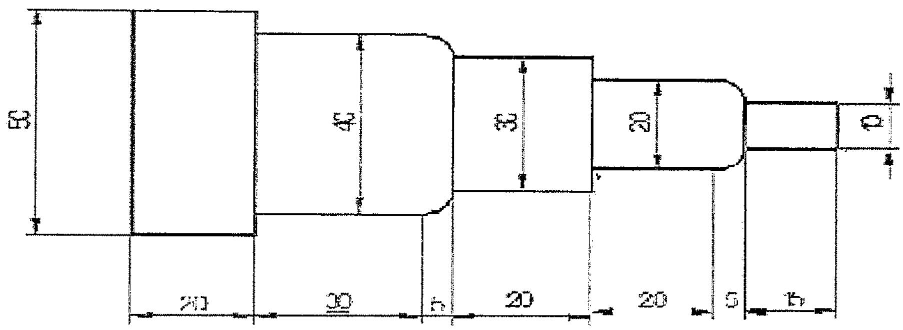
Computer Aided Design and Manufacturing

Time: 3 hrs **Max marks: 100**

Note: Answer any FIVE full questions, choosing one full question from each module

		Module-1
Q.NO 1	a	Explain with neat sketches the fixed, flexible and programmable automations (10 Marks)
	b	The average parts produced in a certain batch manufacturing plant must be processed through an average of six machines. There are 20 new batches of parts launched each week. Other data are as follows. Average operation time: 6 minutes, Average set up time:5 hours, Average nonoperation time:10h/machine, there are 18 machines in the plant. the plant and The plant operates 70 hours per week. Determine i) Manufacturing lead time ii) Plant capacity iii) Work in process iv) Plant utilization.
		OR
Q.NO 2	a	Explain general configuration of automated flow lines with a neat sketch. (10 Marks)
	b	A 22 station in line transfer machine has an ideal cycle time of 0.55 min. The probability of station break down is p=0.01.Average downtime =8 min per line stop. use the upper bound approach and determine: i) Ideal production rate ii) Frequency of line stops iii) Average actual production rate iv) Line efficiency (10 Marks)
		Module-2
Q.NO 3	a	Explain with a neat sketch the software configuration of a graphics system. (10 Marks)
	b	Explain the Computer aided design process with a neat block diagram. (10 Marks)
		OR
Q.NO 4	a	Explain Retrieval type CAPP system with the help of a block diagram. (10 Marks)
	b	Describe the inputs to the MRP system. (10 Marks)
		Module-3
Q.NO 5	a	Define FMS. Explain the types of FMS. (10 Marks)
	b	Enumerate the advantages of group technology. (10 Marks)
		OR
Q.NO 6	a	Explain the following terms in line balancing. i) Minimum rational Work element ii) Precedence diagram iii) Cycle time iv) Balance delay (10 Marks)
	b	A new product is to be assembled in a plant, the data gives the precedence relationship and elemental times Using largest Candidate rule method, i) Construct the precedence diagram for this job ii) If the ideal cycle time is to be 1.5 min, what is the minimum number of work stations required? iii) Calculate the balance delay

Element	1	2	3	4	5	6	7	8
Time 'T_e'(min)	1.0	0.5	0.8	0.3	1.2	0.2	0.5	1.5
Immediate predecessor	-	-	1,2	2	3	3,4	4	5,6,7

		Module-4
Q.NO 7	a	Explain the fundamental steps involved in development of part programming for milling and turning (10 Marks)
	b	Write the Part program to turn the profile of the part as shown in fig.1 (10 Marks) 
		OR
Q.NO 8	a	Explain the different configurations of robot with neat sketches (10 Marks)
	b	Explain the following with reference to precision of robot a) Spatial resolution ii) Accuracy iii) Repeatability (10 Marks)
		Module-5
Q.NO 9	a	Explain with a neat sketch the Sheet lamination process. (10 Marks)
	b	Explain with a neat sketch the Direct energy deposition technique. (10 Marks)
		OR
Q.NO 10	a	Define IOT. Explain the applications of IOT in manufacturing. (10 Marks)
	b	What are the components of Industry 4.0? Explain 4 (10 Marks)

Department: Mechanical
Subject with Subject Code: CADM (18ME72)
Semester: 7

AY : 2022-23

Q NO 1 a)

Fixed Automation

Fixed automation is a system in which the sequence of processing operation is fixed by equipment configaration. Each operation in the sequence is usually simples involving a plain linear (or) rotational motion or combination of two such as feeding of a rotating spindle.

Typical features

1) High Initial Investment for custom engineered equipment.

2) High production rate.

3) Inflexibility of product variety.

The economic justification for fixed Automation is found in product that are produced in very large quantities & at high production rate.

2) Flexible automations

Flexible automation is an extension of Programmable automation. It is Capable of producing a variety of part with virtually no time lost for change over from one part to next. There is no lost production time while reprogramming the system & altering the physical setup. Accordingly the system can produce various parts

Typical features

1) High investment for a custom-engineer system
2) Continous production of variable mixture of products
3) Medium production rate
4) Flexibility to deal with product design.

3) Programmable Automation

In the programmable automation the production equipment is designed with the Capability to change the sequence of operations to accommodate different product configuration. The operation sequence is controlled by a program which is a set of instructions coaded so that they can be read & interpreted by the system.

Typical features

1) High investment in general purpose equipment.

2) Lower production rate than fixed automation

3) Flexibility to deal with variation & changes in product configaration.

4) High Suitability for Batch production.

Q1)
b) Solution

Given

$Q = 25$, $n_o = 6$, $T_c = 6\,min = 0.1\,h$,

$T_{su} = 5\,h$, $T_{no} = 10\,h$, $A = 0.95$, $S_w \cdot H_{sh} = 70\,h/week$

$MLT = ?$ $R_p = ?$ $PC = ?$ $U = ?$

a) Manufacturing lead time (MLT)

$$MLT = n_o (T_{su} + Q T_c + T_{no})$$

$$= 6[5 + 25 \times 0.1 + 10]$$

$$= 105\,h$$

b) Production rate

$$T_b = T_{su} + Q T_c$$

$$T_b = 5 + 25 \times 0.1 = 7.5\,h \text{ per batch}$$

Time per piece $T_p = \frac{T_b}{Q} = \frac{7.5}{25} = 0.3\ h/pc$

$$R_p = \frac{1}{T_p} = \frac{1}{0.3} = 3.33\ pc/hr$$

2) Plant Capacity

$$P_c = \frac{(n \cdot S_w \cdot H_{sh} \cdot R_p)}{n_o}$$

$$P_c = \frac{(18 \times 70 \times 3.33)}{6}$$

$$P_c = 700\ pc/week$$

3) WIP = $WIP = \frac{PC \cdot A \cdot U}{S_w \cdot H_{sh}} \times MLT$

$$= \frac{700 \times 0.95 \times 0.72 \times 105}{70}$$

$$WIP = 723\ PC$$

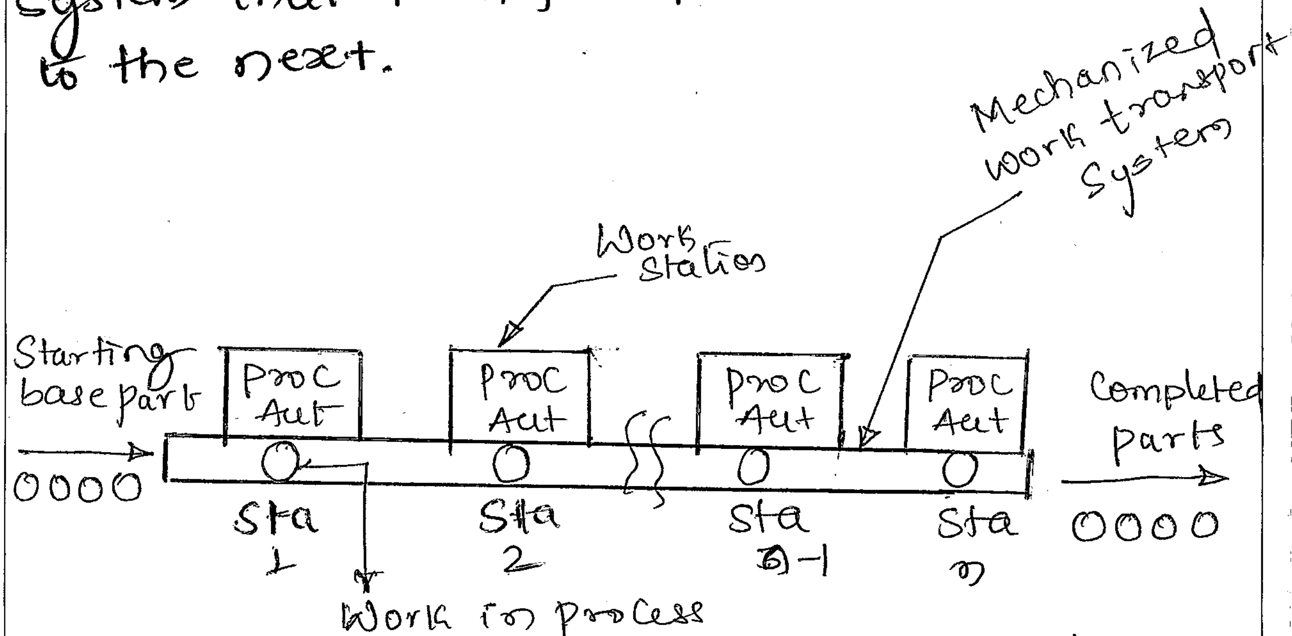
4) Plant Utilization

$$U = \frac{O/P}{Capacity} = \frac{500}{700} = 7.43\%$$

Q2)
a)

Automated flow lines

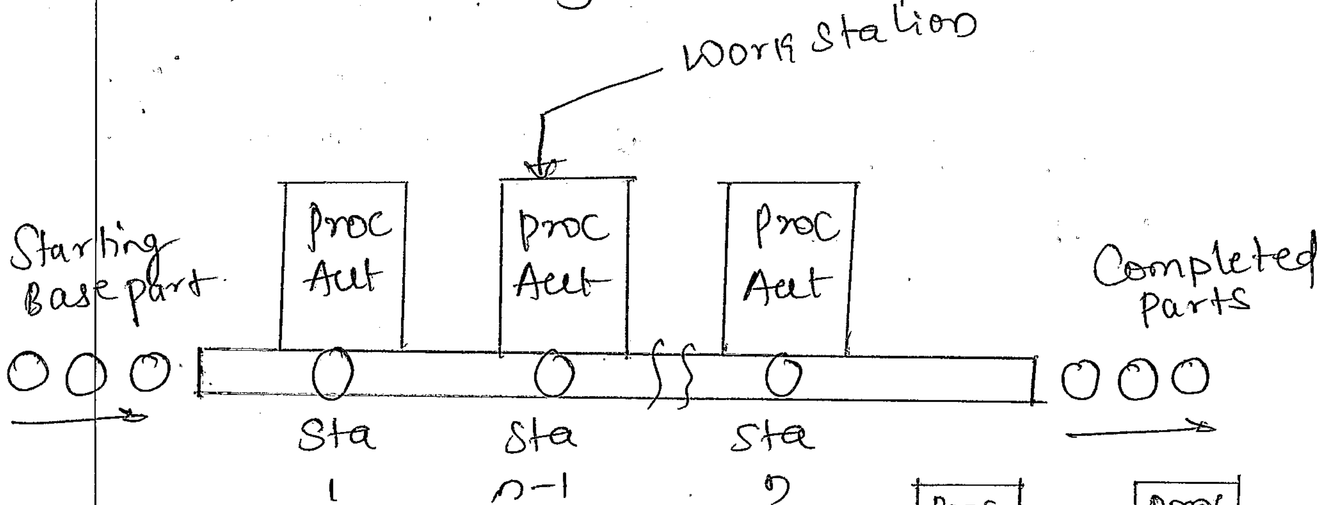
An automated production line consists of multiple work station that are automated & linked together by a work handling system that transfer part from one station to the next.



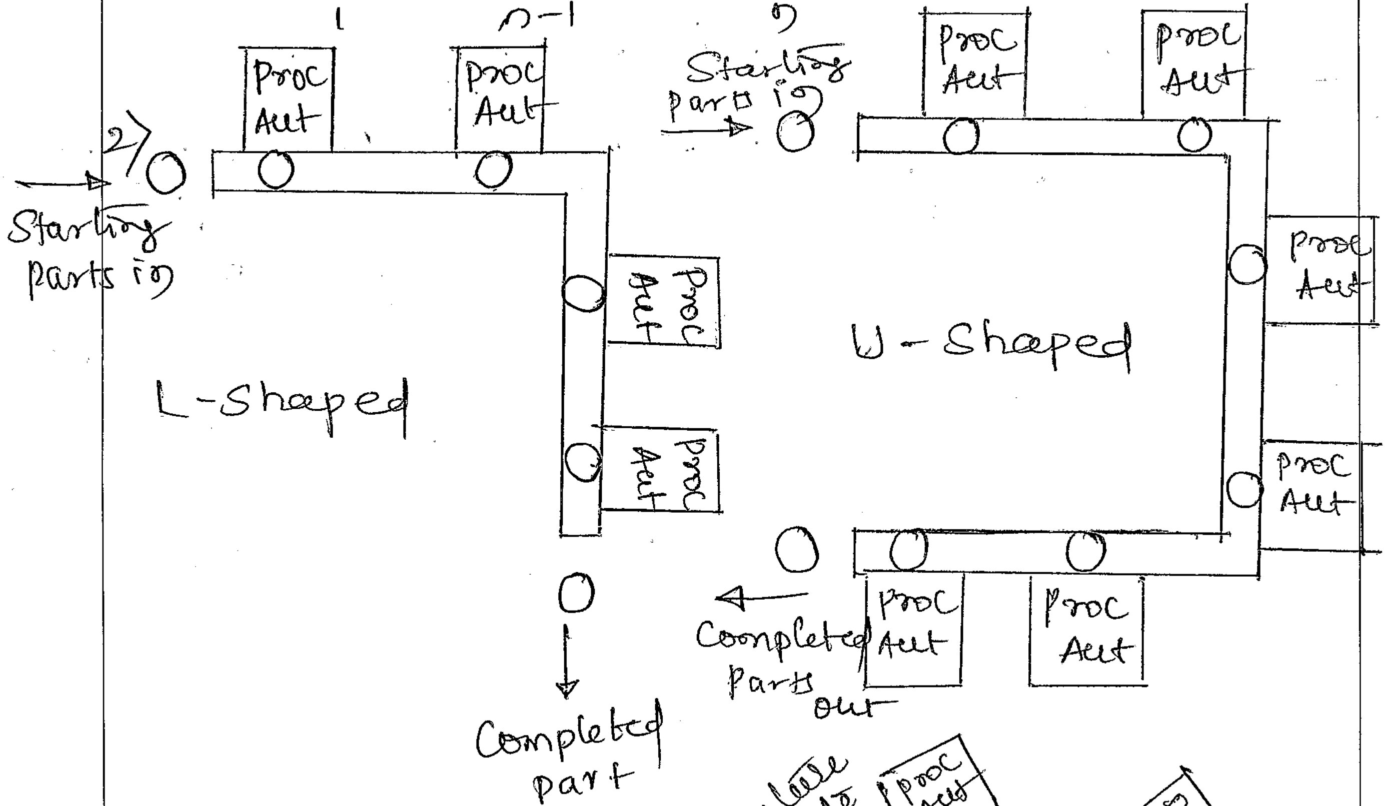
A raw work enter one end of the line & processing is performed & part will move from left to right. The line may include inspection for quality check manual station may be located for some operation that are uneconomical to automate. Each station perform a different operation so all the operation are required to complete one work unit. Multiple parts are processed simultaneously on the line one part at each work station. In the simplest form of production line, the number of parts on the line equal to no of workstation.

Automated flow line Configaration

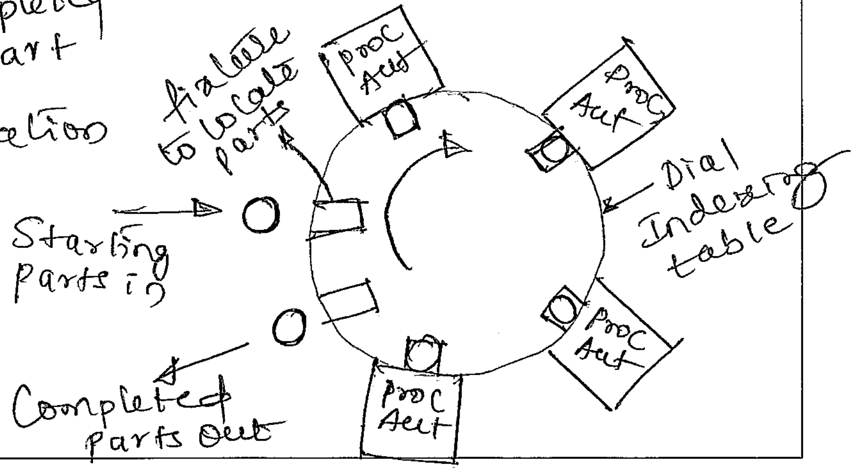
1) In-line Configaration



2)



3) Rotary Configaration



Q2) b)

Solution

Given — Upper-bound approach

$n = 22$

$T_c = 0.55$ min

$P = 0.01$

$T_d = 8$ min

i) $F = ?$

ii) $R_p = ?$

iii) $E = ?$

i) Frequency of line stops

$F = nP$

$F = 22 \times 0.01$

$F = 0.22$ breakdowns/cycle

ii) Average production rate, R_p

$$R_p = \frac{1}{T_p}$$

$T_p = T_c + F \cdot T_d$

$T_p = 0.55 + 0.22(8)$

$T_p = 2.31$ min/pc

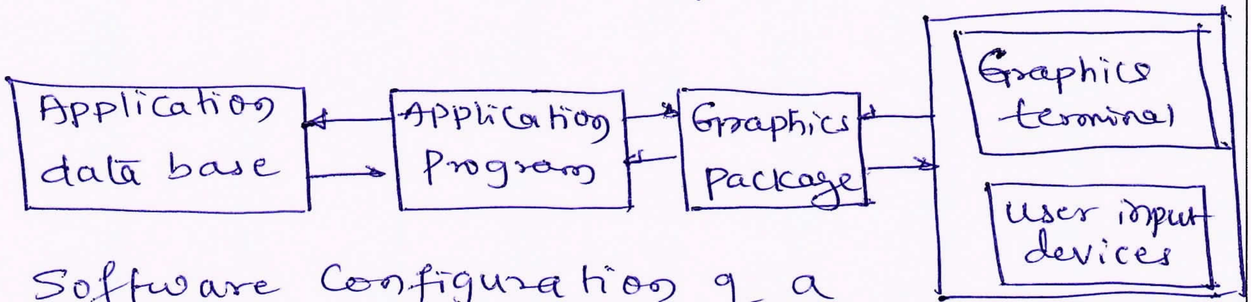
iii) Line efficiency

$$E = \frac{T_c}{T_p}$$

$$E = \frac{0.55}{2.31}$$

$E = 23.80\%$

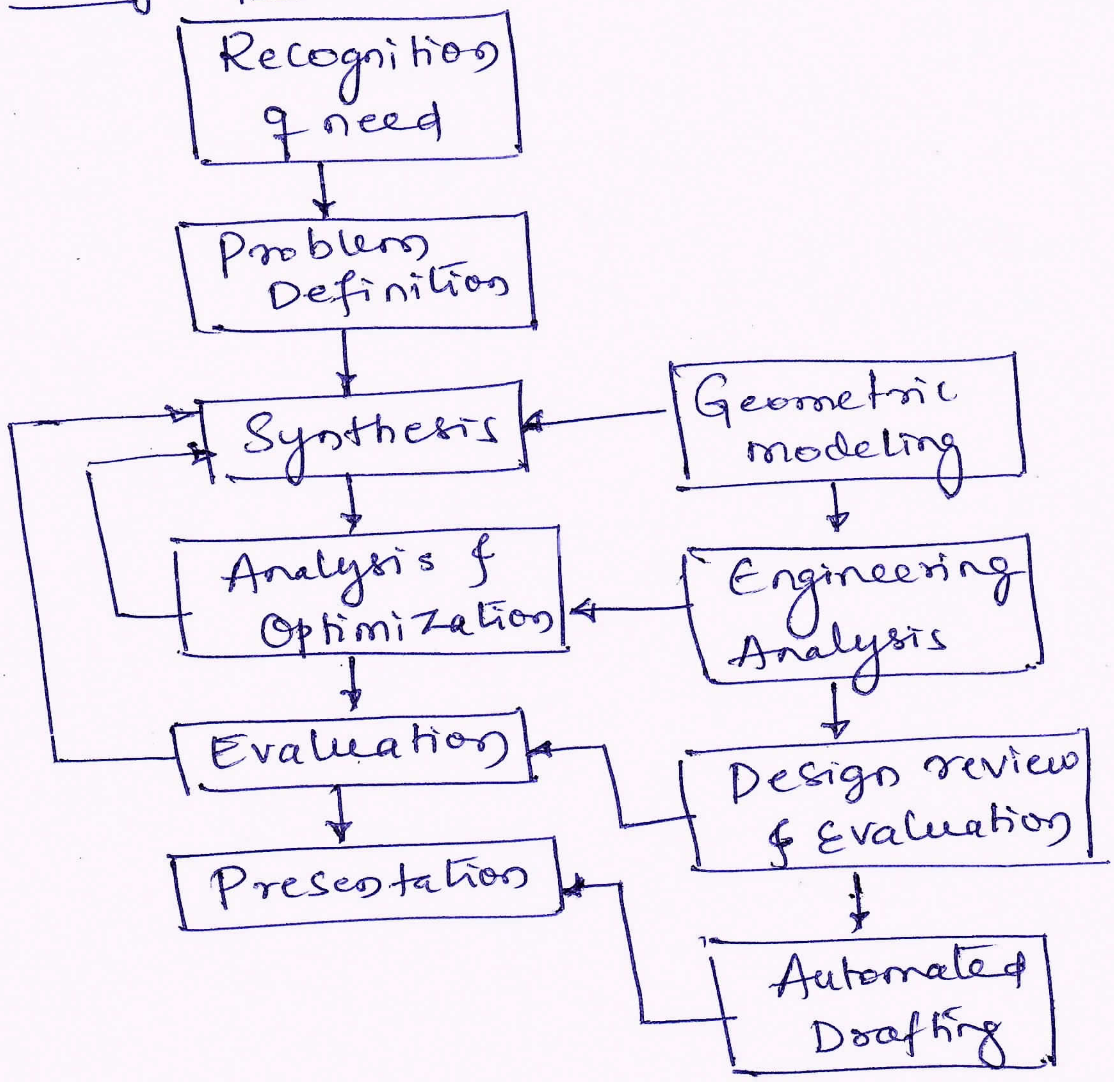
Q3)
a) Software Configuration of a graphics System.



Software Configuration of a graphics System mainly consists of three conceptual model
1) The graphics package
2) Application program
3) Application Database

The Central Module is application program.
- It Controls the Storage of data into and retrieves data out of the application data base.
- The application program is implemented by the user to construct the model of a physical entity whose image is to be viewed on the graphics Screen.
- Application program are written for particular problem areas. problem areas in engineering design would include architecture, Construction, Mechanical Components, electronics, chemical Engineering, and aerospace Engineering.
- The data base Contains mathematical, numerical and logical definitions of the application models, Such as electronic Circuits, mechanical Component, automobile bodies, and so forth
- It also includes alphanumeric information associated with the models, Such as bills of materials, mass properties and other data.

Q3)
b) <u>Design process</u>



Recognition of need involves the realization by some one that a problem exists that a thoughtful design could solve. This recognition might mean identifying some deficiency in a current machine design by an engineer or perceiving some new product opportunity by a salesperson.

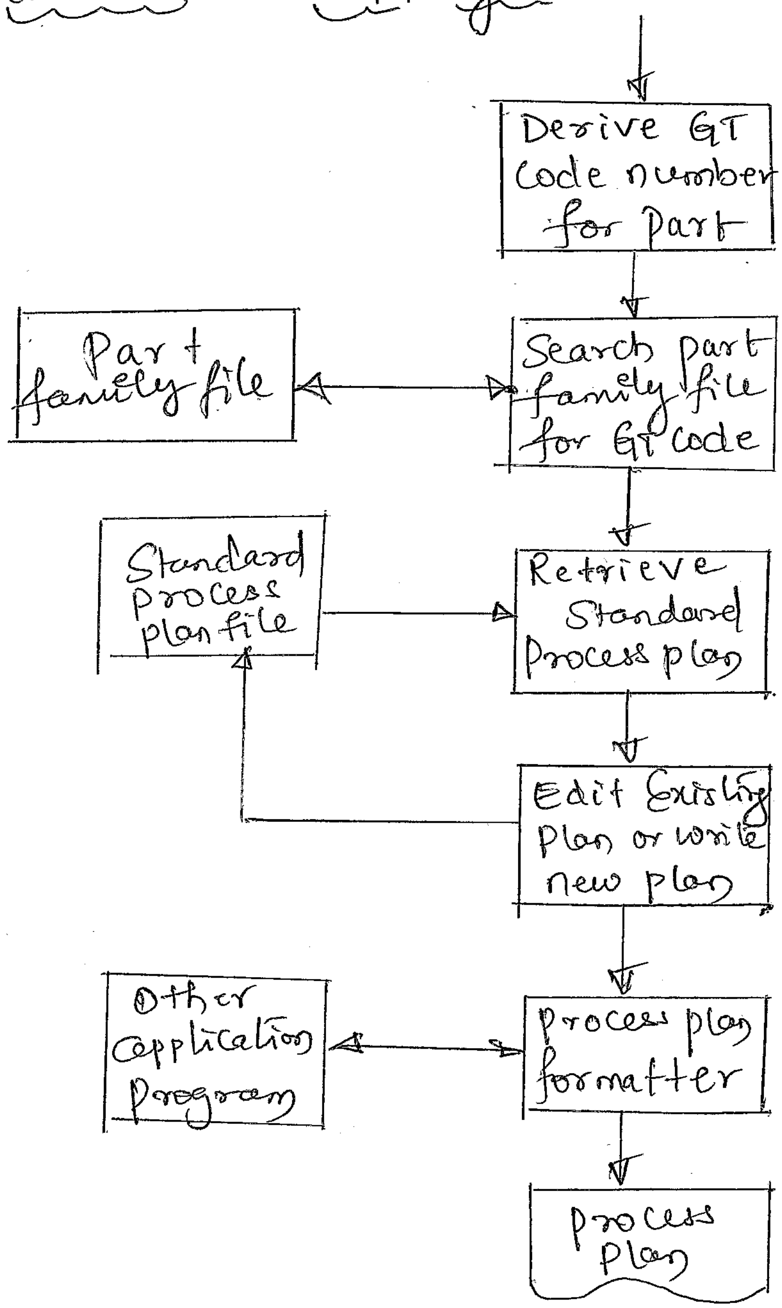
Problem definition involves a through specification of the item to be designed. This specification includes the physical characteristics, functions, cost, quality & operating performance.

Synthesis and Analysis are closely related and highly interactive. Consider the development of a certain product design. Each of the subsystems of the product must be conceptualized by the designer, analyzed, improved through this analysis procedure, redesigned analyzed again. the process is repeated until the design has been optimized within the constraints imposed on the designer. The individual imposed on the designer. The individual Components are then Synthesized and analyzed into the final product in a Similar manner.

Evaluation is concerned with measuring the design against the specification established in the problem definition phase. This Evaluation often requires the fabrication of testing of a prototype model to assess operating performance, quality, reliability, and other criteria. The final phase in the design procedure is the Presentation of the design.

Presentation is concerned with documenting the design by means of drawings, material specifications assembly lines & so on. In essence, documentation means that the design database is created.

Q4) a) Retrieval CAPP System

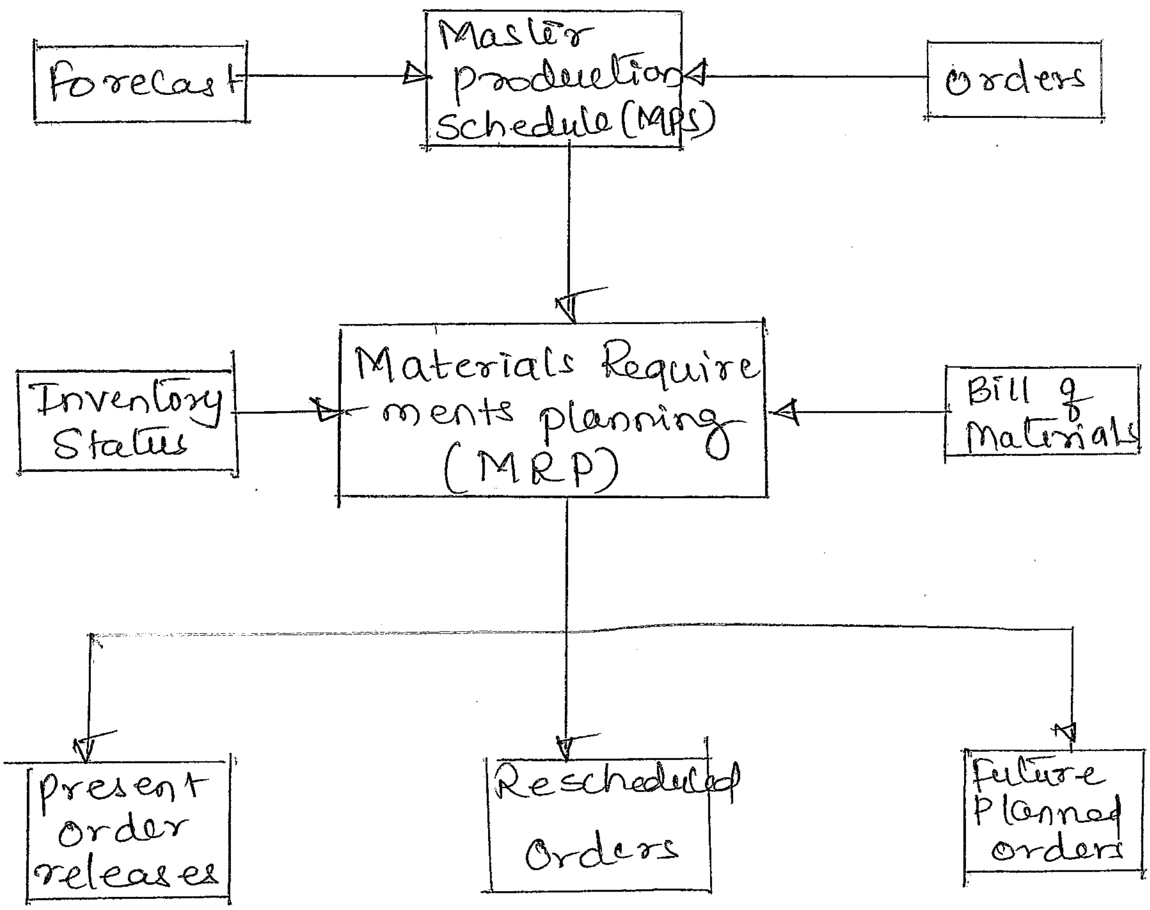


Retrieval type CAPP, also termed Variant CAPP Systems, are designed using the principles of Group Technology & parts Classification & Coding. As per this System a Standard process plan is prepared for each part Code number & Stored in a Computer. Preparation of this data base is a major task & can be

based on the existing routings or on ideal plan.
The functioning of retrieval CAPP Systems is shown in fig. It begins with deriving the GT Code for the part for which the process plan has to be prepared. using this Code in the part family file in the Computer its standard Route card is Searched. If there Exists a Standard route card, it is retrieved and displayed on the monitor Screen. The engineer then studies the plan & checks if any modification are required. Even though the new part has the Same code number there Could be Some minor differences in the required processes. If required the engineer edits the Standard plan as per the requirements. Because of this ability to modify the existing process plan this System is given the name variant CAPP system.
If the Search for a route Card for the given Card Code fails, then the engineer can Search for a file for Similar or related code number having a standard route card. He can either use this or write a new process plan for the part, which then becomes the standard process plan for the new part Code number.

Q 4) b)

Inputs to the MRP System



1) Master Production Schedule (MPS)

A master production schedule is a basic input to the MRP System. It specifies the complete requirements of an end product, its quantity and time of requirement. It is a production plan developed on the basis of inputs like firm customer orders and demand forecast. The MPS forms a basis of ~~inputs like~~ material procurement timings, production of assemblies / sub assemblies, to meet the final product schedules.

2) Inventory Status

In an MRP System the data on the inventory Status is most essential, to plan & schedule the Requirements. The inventory Status information must indicate the on hand quantities, gross requirements, Scheduled Receipts & planned order releases for the item. It should also contain conformation like Lot sizes, lead times, Saftey Stock levels, etc, for the materials.

3) Bill of Materials (BOM)

A BOM Consists the details of materials, parts and Sub assemblies that make an end product. The BOM file represents each & every part by a unique identification number & helps processing by a process which translates end-item requirements into Component Requirements.

Q NO 5)

a) Flexible Manufacturing System

"A flexible Manufacturing System (FMS) Consists of a group processing Stations interconnected by an automated material handling and Storage system and Controlled by an integrated Computer System"

Types of FMS

1) Single machine cell

- Consists one CNC machining center Combined with parts storage system for unattended operation
- Completed parts are periodically unloaded from the parts storage unit & raw work parts are loaded into it.
- The System Satisfied three of the four flexibility tests
- Part variety test, Schedule change test, new part test.
- The System fails error recovery test.
- If the Machine break down, production stops.

2) Flexible Manufacturing Cell (FMC)

- Consists of two or three processing workstations plus a part handling system.
- part handling System is Connected to a load unload station
- The handling system usually includes a limited parts storage capacity
- Satisfied the four flexibility test.

3) Flexible Manufacturing System (FMS)

- Has four or more processing work stations Connected mechanically by a Common part handling System and electronically by a distributed Computer System.
- Generally includes non-processing workstation that support production but donot directly participate in it.
- Computer Control System is generally larger & more Sophisticated often including functions such as dignostics & tool monitoring.

QNO5)

b) Advantages of Group Technology

1) Better lead times result in fast response and more reliable delivery.
2) Material handling is reduced Considerably.
3) Robots Can be easily used for material handling.
4) Better Space utilisation
5) Smaller variety of tools, jigs & fixtures.
6) Improved quality & less Scrap.
7) Outputs is improved due to improved Resource utilisation.
8) Work in progress and finished stock levels are reduced.
9) Simplified estimating, accounting, & work management.
10) Improved plant replacement decisions.

Q6) a) i) Minimum rational work element.

In the design and analysis of a line balancing problem, the first step is to divide the total assembly work into its component tasks. Each task is referred to as ~~the~~ the minimum rational work element. These are the smallest work elements that cannot be divided further and are performed either on a single or multiple workstations. for example, drilling a hole, fastening one part to another, are all minimum work elements.

ii) Precedence diagram

Once the precedence constraints are understood and the sequence is known, then the work elements are arranged and represented by a graphical mode. This graphical representation of the sequence of work elements is termed the precedence diagram. Each of the work element is represented by a circle, with the element number inside the circle, and the work element time outside the circle. The work elements are then connected by arrows.

iii) Cycle time

This reffrs to the local time taken to Complete the assembly process in an assembly line. In other words, it is the time interval between parts coming out of an assembly line.

$$T_c = \frac{60E}{R_p}$$

T_c = Cycle time min/cycle
E = Line Efficiency
R_p = Production rate, Pc/hr

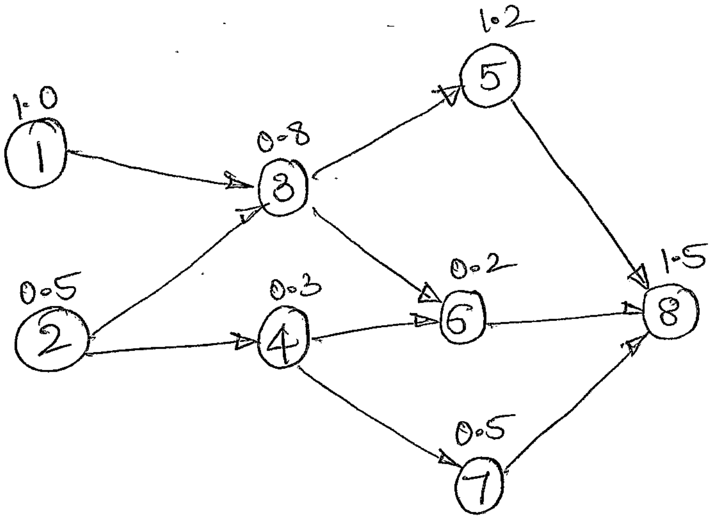
iv) Balance Delay

This is also referred to as the balancing loss. It is a measure of the inefficiency of the assembly line, that occurs from idle time, may be due to technically in correct assignment of work elements among different work station.

Q6)
b) Solution

Largest Candidate Rule

a) Precedence diagram



b)

Element	Tek, min	Preceded by
8	1.5	5, 6, 7
5	1.2	3
1	1.0	—
3	0.8	1, 2
2	0.5	—
7	0.5	4
4	0.3	2
6	0.2	3, 4

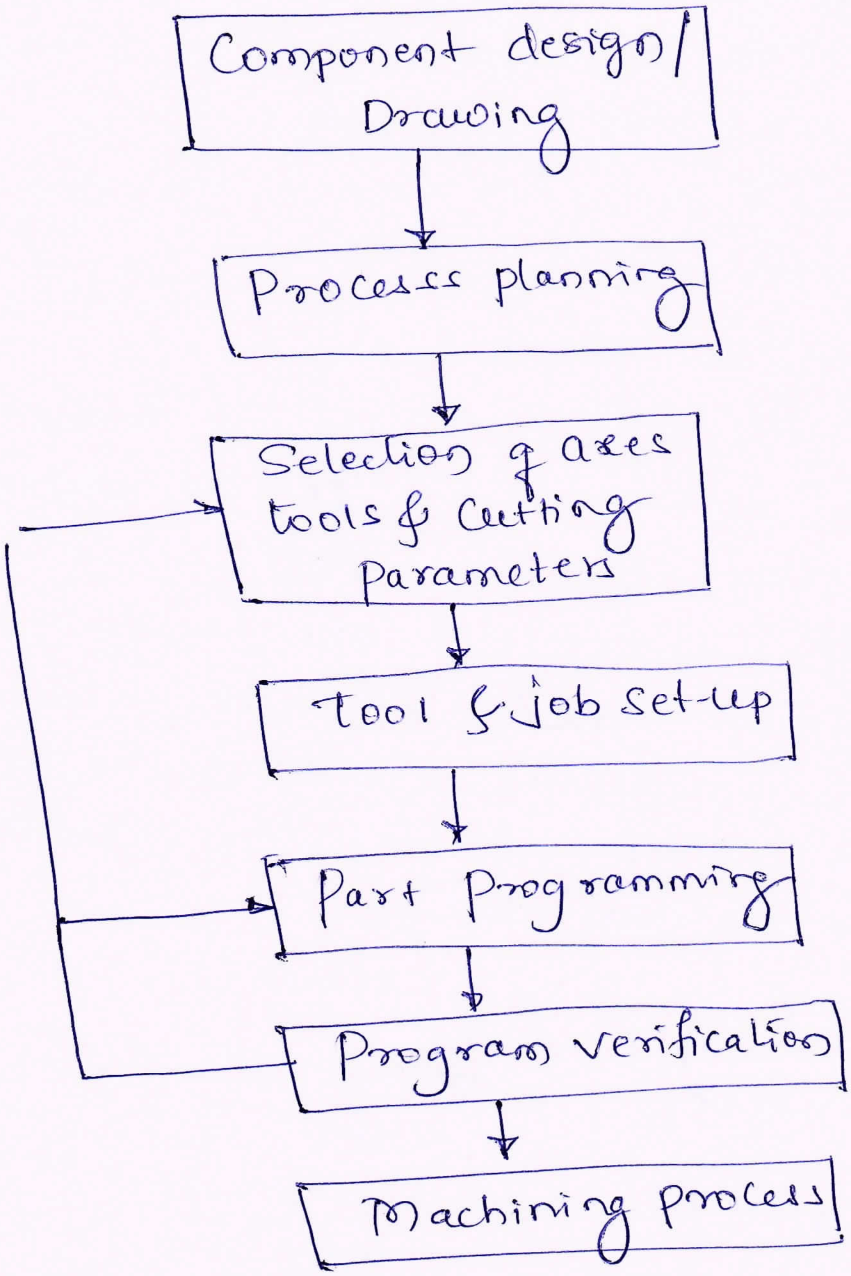
Station	Element	Tek, min	ΣTek (min)	Idle time
1	1	1.0	1.5	0.0
	2	0.5		
2	3	0.8		
	4	0.3		
	6	0.2	1.3	0.2
3	5	1.2	1.2	0.3
4	7	0.5	0.5	1.0
5	8	1.5	1.5	0

c) Balance Delay

Line efficiency $E_b = \frac{T_{wc}}{w \cdot T_s} = \frac{6}{5 \times 1.5} = 80\%$.

$D_b = 100 - E_b = 100 - 80 = 20\%$.

Q 7)
a) Steps Involved in development of Part Program



1) Process planning

Any design transformed in to engineering drawing cannot be straight away taken to shop production. The process involved should be studied & planned in a proper fashion. This is called process planning.

2) Selection of Axes

It is essential to select necessary axes for the programming & machining. Most NC machines come with a specified datum / reference position / axis. The other axes can be selected based on the datum position.

many times part programmer finds it not Convenient to work with the fixed datum position. Instead they try to work with the floating datum, in which case the programmer can fix a reference datum any where within the machining limits.

3) Selection of tools

The selection of suitable tools to be used in an NC machine is an essential step in programming. The types of tools required depend mainly of the component geometry, contours size & the machining operations to be performed. this selection also depends on the tool availability, machining economics & part complexity.

4) Selection of cutting parameter

The cutting parameters like the cutting speed, feed, depth of cut change of tool, etc. need to be decided & included in the part program. In fact, this step forms an important part of the part program. Again the selection of these parameters depends on the type of material being cut, complexity of cutting action, geometry etc.

5) Job & tool set up

Most NC machines through automatic require initial job setting and tool setting for new operations. once the setting is complete, the same can be continued until the program is changed. the job & tool set-up parameters are included in the part program.

6) Part Programming

Once the sequence of operations is planned, these are programmed as a set of instructions this operation is called part programming.

7) Program Verification and Feed back

Program verification after part programming is essential to ensure that the program produces the part to the desired shape & size by performing the proper sequence of operations.

8) Machining

The final step in NC system is to use the verified NC part program for actual machining process. This involves raw material loading, tool setting & other fixturing work.

Q7)

b)

```
M06 T0101
G21 G90 G54 G00 X0 Z0
G50 S200
G00 X60 Z2 S300 M03 M08
G71 W1 R0.5
G71 P01 Q06 U0.25 W0.25
N01 G00 X10 Z00
N02 G01 X10 Z-15
N03 G01 X20 Z-25 R5
N04 G01 X20 Z-40
N05 G01 X30 Z-40
N06 G01 X30 Z-60
N07 G01 X40 Z-65 R5
N08 G01 X40 Z-95
N09 G01 X50 Z-95
N10 G01 X50 Z-115
M09
M05
G00 X100 Z10
M30
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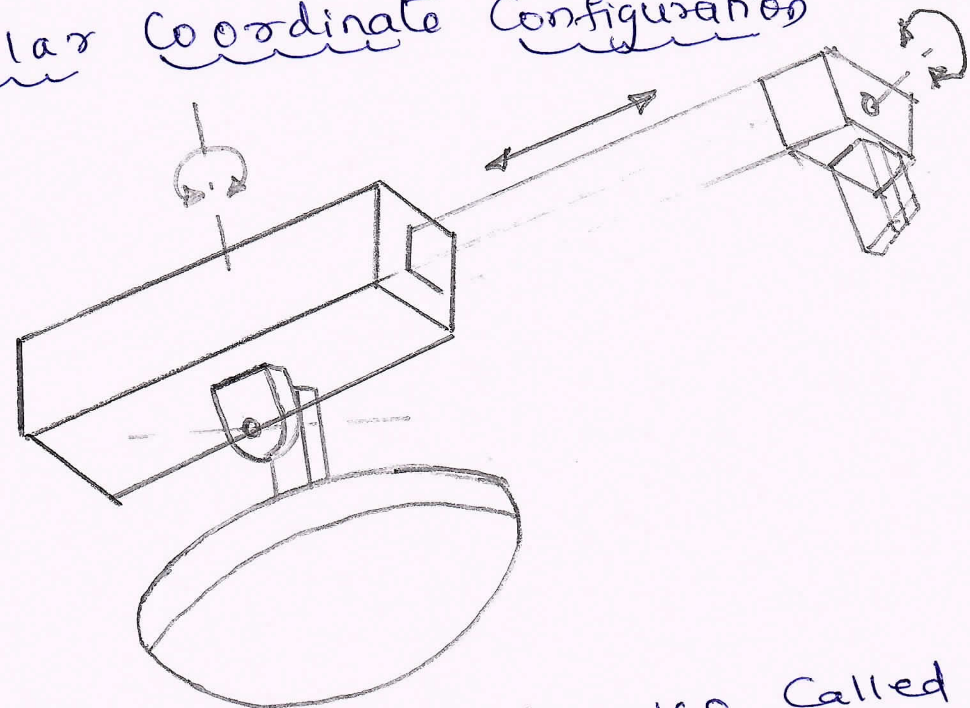
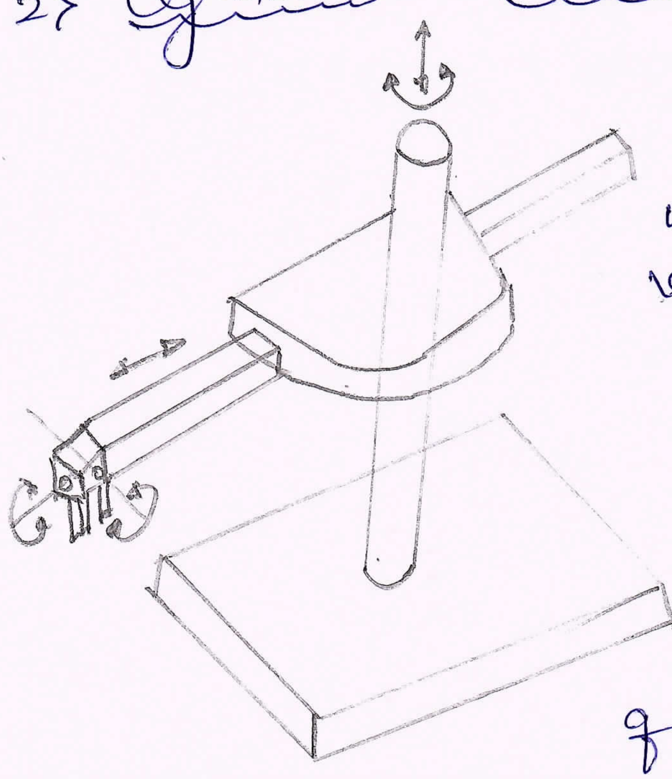
Q No 8
a) Different Configurations of robot

1) Polar Coordinate Configuration



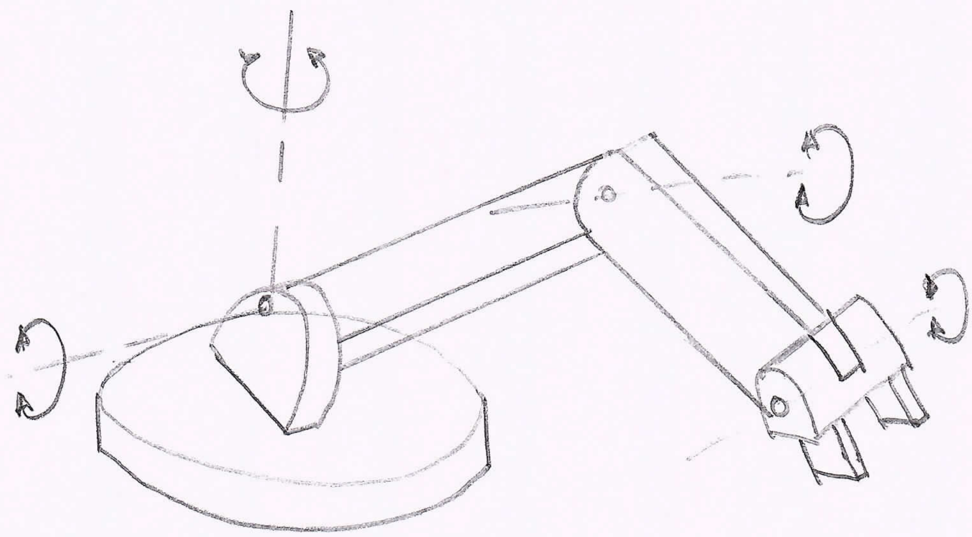
This Configuration is also Called by the Some Spherical Coordinate Configuration, Since the workspace within which it moves its arm is a partial Sphere. This robot has a rotary base, & a pivot that can be used to rise and lower its telescoping arm. The work volume is a partial Sphere, that means it can function within a volume of partial Sphere

2) Cylindrical Coordinate Configuration



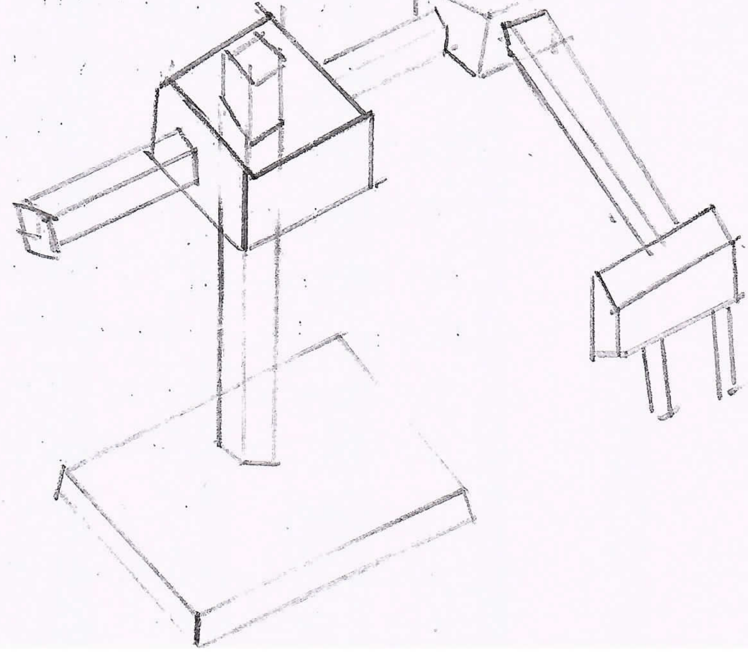
This robot Configuration has a Vertical Column, which Swivels about a vertical axis. the arm Consists of Several orthogonal Slides, which help the arm to move up or down, in & out with reference to its body. the work Volume of this Configuration is cylindrical.

3) Jointed arm Configuration



This Configuration has an arm that is Similar in appearance to the human arm. The arm consists of many straight members Connected by joints, hence the name jointed arm configuration. The joints in this are analogous to the human shoulder, elbow & wrist. The full arm is mounted on a base which can rotate the full system to give a work volume of quasi - spherical space.

4) Cartesian Coordinate Configuration



This Configuration Consists of three Orthogonal slides. The three slides move in x, y & z directions hence the name Cartesian Co-ordinate system. Maximum x, y, z position of the arm gives the highest work volume of the robot. Obviously the work volume of this robot Configuration is a rectangular space.

Q8)

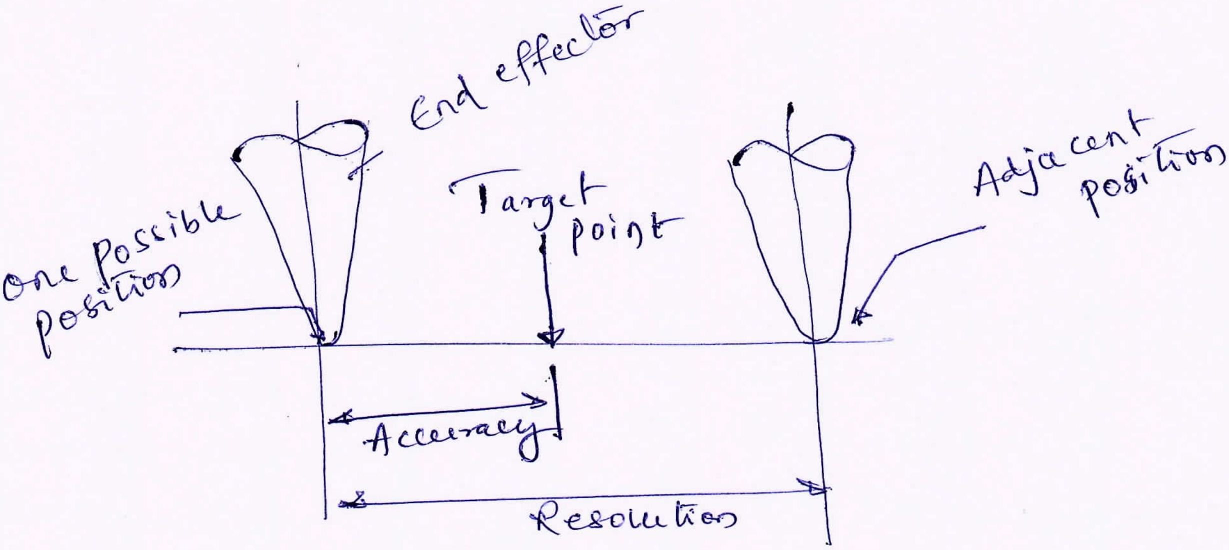
b) i) Spatial Resolution

It refers to the smallest increment of motion at the wrist end that can be controlled by the robot. This depends on the robot's control resolution which in turn depends on it's position control & feedback measurement systems. It is also influenced by the mechanical inaccuracies in the robot's joints. Hence, the Spatial resolution is the sum of the control resolution of these mechanical inaccuracies. Control Resolution depends on factors like the range of movement of the arm and the bit storage capacity in the control memory.

ii) Accuracy

Accuracy of a Robot can be defined as its ability to position its wrist end at a desired target point within its reach. Accuracy and Spatial Resolution are closely related since a Robot's ability to reach a particular point in space depends on it's ability to divide

it's joint movements into small increments.
Interms of Sapatial resolution the accuracy can be defined as one half of the resolution. This definition of accuracy holds good in the worst case when the target point is between two control points.



c) Repeatability

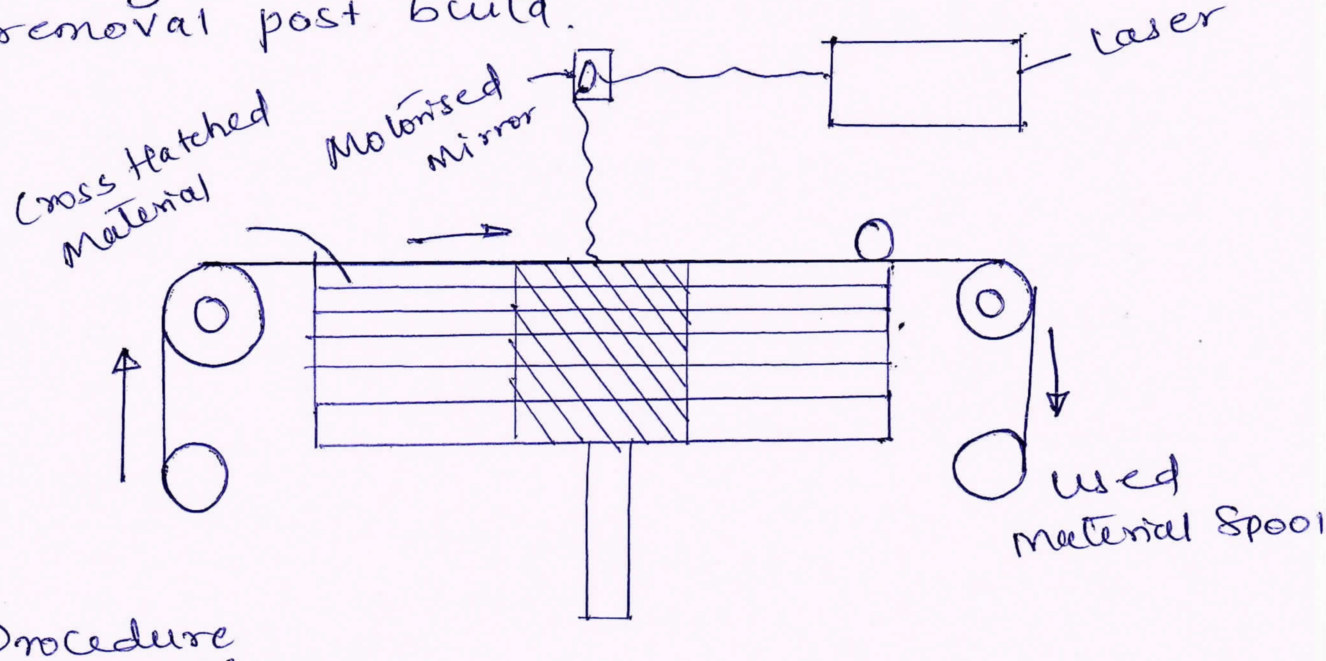
Repeatability of a robot can be defined as its ability to position its end effector at a point in its work volume that had been previously taught to it.
Repeatability is different from accuracy.

9)
a)

Sheet Lamination Process

Sheet lamination process includes ultrasonic additive manufacturing (UAM) and laminated object manufacturing. The Ultrasonic Additive Manufacturing process uses sheets or ribbons of metal, which are bound together using ultrasonic welding. The process does require additional CNC machining and removal of the unbound metal, often during the welding process.

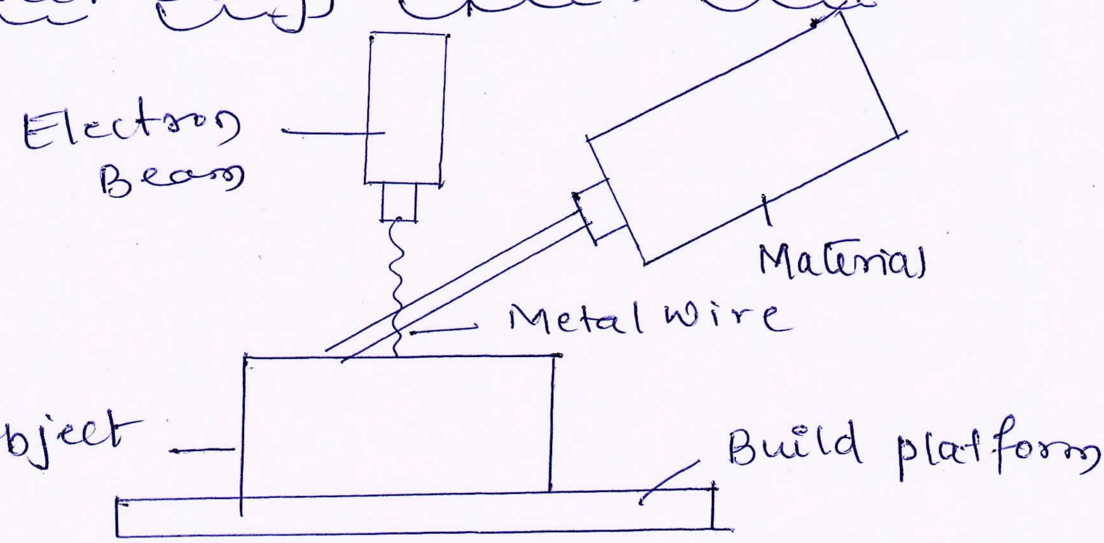
Laminated object manufacturing (LOM) uses a similar layer by layer approach but uses paper as material & adhesive instead of welding. The LOM process uses a cross hatching method during the printing process to allow for easy removal post build.



Procedure

1) The material is positioned in place on the cutting bed.
2) The material is bonded in place, over the previous layer, using the adhesive.
3) The required shape is then cut from the layer, by layer or knife.
4) The next layer is added.
5) Steps two & three can be reversed & alternatively the material can be cut before being positioned & bonded

Q9) b) Direct Energy Deposition technique



Direct Energy Deposition (DED) covers a range of technology: 'Laser engineered net shaping, directed light fabrication, direct metal deposition, 3D laser cladding' it is a more complex printing process commonly used to repair or add additional material to existing component.

Procedure

1) A 4 or 5 axis arm with nozzle moves around a fixed object
2) Material is deposited from the nozzle onto existing surfaces of the object.
3) Material is either provided in wire or powder form.
4) Material is melted using a laser, electron beam or plasma arc upon deposition.
5) Further material is added layer by layer & solidifies, creating or repairing new material features on the existing object.

Q No 10)

a) IOT — Internet of things

The Internet of things (IoT) is the network of physical devices, vehicles, home appliances and other items embedded with electronics Software sensors actuators & network Connectivity, which ~~eab~~ enables these objects to connect and exchange data.

IoT applications in manufacturing

1) Digital | Connected factory

IoT enabled machinery can transmit operational information to the partners like original equipment manufacturers and to field engineers. This will enable operation managers and factory heads to remotely manage the factory units & take advantage of process automation & optimization.

2) Facility Management

The use of IOT sensors in manufacturing equipment enables condition-based maintenance alerts. There are many critical machine tools that are designed to function within certain temperature and vibration ranges. IoT sensors can actively monitor machines and send an alert when the equipment deviates from it's prescribed parameters

3) Production flow monitoring

IoT in manufacturing can enable the monitoring of production lines starting from the refining process down to the packaging of final products.

4) Inventory management

IoT applications permit the monitoring of events across a supply chain. using these systems the inventory is tracked and traced globally on a line-item level and the users are notified of any significant deviations from the plans. this provides cross-channel visibility to inventories and managers are provided with realistic estimates of the available material, work in progress & estimated the arrival time of new material.

5) Plant Safety and Security

IoT combined big data analysis can improve the overall workers safety & security in the plant. By monitoring the key performance indicators of health & safety, like the number of injuries and illness rates, near-misses, short & long term absences, vehicle incidents & property damage or loss during daily operations.

6) Quality Control

IoT sensors control aggregate product data and other third-party syndicated data from various stages of a product cycle. this data relates to the composition of raw materials used, temperature & working environment, wastes, the impact of transportation etc. on the final product.

7) Packaging optimization

8) Logistics and supply chain optimization

Q10)
b) Components of Industry 4.0

1) Advanced Robotics
- Autonomous, cooperating industrial robots.
- Numerous integrated sensors and standardized interfaces.

2) Additive Manufacturing
- 3D printing, particularly for spare parts & prototypes.
- Decentralized 3D facilitises to reduce transport distances & inventory

3) Augmented Reality
- Augmented reality for maintenance, logistics, and all kinds of SOP.
- Display of supporting information eg: through glasses.

4) Simulation
- Simulation of value networks
- Optimization based on real-time data from intelligent systems

5) Industrial Internet
- Networks of machines & products
- Multidirectional communication between networked objects.

6) Cloud
- Managment of huge data volumes in open systems
- Real time communication for production system

7) Cybersecurity
- Operation in networks and open systems
- High level of networking between inteligent machines, products, & systems

8) Big Data & Analytics -

- Full evaluation of available data (eg from ERP, SCM, MES, CRM, & machine data)
- Real time ~~direc~~ decision making support & optimization.

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