

Q.1(a) Attempt any THREE of the following:

[12]

Q.1(a)(i) Define productivity? State the factors which improves productivity.

[4]

(A) Productivity

Productivity may be defined as the ratio of output to input. The output means the amount produced and input are the various resources employed.

Productivity is an attitude of mind. It mentality of progress, of the constant improvement of that which exist. Productivity is the efficiency with which the resources are employed.

Factors which improves productivity

Factors related to

- (i) **Employee** : quality circle, training, workers participation in decision making, promotion.
- (ii) **Process** : work study, methods engineering, job evaluation, SQC.
- (iii) **Product** : Product mix and promotion, standardization and simplification, value engineering etc.
- (iv) **Working conditions** : occupational safety, ventilation, illumination, ergonomics.
- (v) **Management** : motivation, work culture.
- (vi) **Technology** : robotics, FMS, CAE, CIMS JIT etc.

Q.1(a) (ii) Explain the factors affecting process planning.

[4]

(A) Factors affecting process planning :

(i) Size and shape of part

The size and shape of many components decides the basic operations for the manufacturing of part. For example : For manufacturing a shaft, the necessity information is shape of raw material, size of shaft, according to that we select the sequence of operations, machines to be used and material handling activities.

(ii) Strength characteristics of the part

The part strength also decide that which type of process is employed for producing it. Because the different types of load acted on the part during its working such as impact load, tensile load or shock load etc. according to that process planning is done.

(iii) Quantity required

According to the no. of output produced, the process planning is decided. For example: Part which is manufacture in large no. for that general purpose machine is used and for large size and less no. of part special purpose machines are used.

(iv) The accuracy and surface quality required

For achieving accuracy, product should be manufactured such a way that it should give higher dimensional accuracy and high degree of surface finish according to that machines and process is to be selected.

(v) Utilization of existing equipments

While selecting the process, full capacity of existing machines & its tooling must be utilized, otherwise the existing machinery will remain idle and more capital will be invested on new machines.

(vi) Skill of manpower

Skill of available manpower must be known to determine the need for added operations to avoid defectives due to poor workmanship.

(vii) Delivery date of components or product

Short time period of delivery generally do not allow process engineer to select most economical process and tool for economic production. Due to insufficient time, he may use less efficient machine and tool on hand. On other hand, longer delivery schedule give process engineer sufficient time to go details of each aspect to select most economical process.

- Q.1(a) (iii) Compare between various types of production systems with respect to [4]
 (a) Product (b) Layout
 (c) Machines used (d) Cost of product

(A)

	Production system	Product	Layout	Machines	Cost of product
(i)	Job Production	Products are made to satisfy a specific order.	Process layout. Fixed layout if job is bulky.	Machines and methods employed should be general purpose.	Product cost is normally high.
(ii)	Batch production	Manufacture of a number of identical articles either to meet a specific order or to meet a continuous demand.	Process layout	Machines are grouped on functional basis. Semi automatic, special purpose automatic machines are generally used.	Cost of production is more than mass production system and less than job production system.
(iii)	Mass production	Same type of product is manufactured to meet the continuous demand of the product.	Product layout	Machines can be laid down in order of processing sequence. Special purpose automatic machines/CNCS are used. FMS can be used to expedite the rate of production.	Cost of production is low owing to the high rate of production.

- Q.1(a) (iv) What is line balancing? Why it is necessary? [4]

(A) **Concept of Line Balancing:**

Assembly Line Balancing is associated with a product layout in which products are processed as they pass through a line of work centres. It means balancing the production line or assembly line for producing same amount of the work.

- (i) An Assembly line can be considered as a Production sequence, where parts are assembled together to form an end product.
- (ii) In Assembly lines the operations are carried out at different work stations situated along the line.
- (iii) Line balancing is the appointment of sequential work activities into work stations in order to gain a high utilization of labor and equipment so as to minimize the idle time.
- (iv) There are different balancing methods are used to solve the line balancing problems such as Heuristic Method, Rank Position Weightage Method, Linear Programming, Dynamic Programming and Computerized Methods.

Necessity/Requirement of Line Balancing:

- (i) To distribute the tasks evenly at every work station so that the idle time of men and machines is distributed equally.
- (ii) To minimize the idle time of men's and machines in line.
- (iii) To provide perfect balance when the assignments provide no idle time.
- (iv) To group the work and workers.
- (v) To obtain an optimum balance of capacities on assembly line.

Q.1(b) Attempt any ONE of the following: [6]

Q.1(b) (i) Discuss in brief important factors to be considered while making 'site selection' for a new industry/plant. [6]

(A) Factors to be considered while making 'site selection' for new industry/plant:

(1) Availability of raw material

As far as possible the site selected should be near the source of raw materials so that cost of transportation can be minimized and storing cost can be reduced especially when the raw material is heavy and bulky or cheap but loses a good amount of weight during processing. For example most of the iron and steel industries are situated in Orissa and Bihar, Paper industries in Ballarpur due to availability of raw material in these areas.

(2) Availability of labour

Available of right kind of labour in required numbers of reasonable rates is also deciding factor in site selection. Unskilled labours are amply available at major industrial areas and rural areas but however firms requiring skilled labour be situated near the urban industrial area.

(3) Climatic condition

Climatic conditions largely affect certain production processes and also the efficiency of employees. For example textile industries required moist climate due to which these types of industries are situated near Ahmadabad and Mumbai; similarly Tea and Coffee near Assam.

(4) Proximity of market

Market is another important factor affecting site selection. Industrial units using raw material should be located near the markets to serve the customer with minimum service cost.

(5) Transport and communication facilities

While selecting the site, adequate transportation facilities should be considered. The optimum site is the site which is well connected by various modes of transportation.

(6) Availability of water

Water is required for drinking and sanitary purpose of all industries. Therefore, clean and adequate water should be available near the site.

(7) Availability of power and fuel

All industries require power and fuel to run the prime movers. Therefore, the site selected should have these facilities available at cheaper rate.

(8) Legal Aspects

Local bye laws, taxes etc. are also important because they directly reflect in total cost. So while selection, it should also consider legal aspects.

(9) Amenities and recreational facilities

Facilities like schools, hospitals, garden, play grounds should also be needed for employee and their family.

(10) Scope of Future expansion

Site selected should be in such a way that a plenty of land other facilities must be available for future expansion.

Q.1(b) (ii) Explain how Gantt chart is used in project planning with proper example. [6]

(A) Use of Gantt Chart in Project Planning:

Gantt Chart is a project planning tool that can be used to represent the timing of tasks required to complete a project. Because Gantt charts are simple to understand and easy to construct, they are used by most project managers for all but the most complex projects.

(i) In a Gantt Chart, each task takes up on row.

(ii) Dates run along the top in increments of days, weeks or months, depending on the total length of the project.

(iii) The expected time for each task is represented by a horizontal bar whose left end marks the expected beginning of the task and whose right end marks the expected completion date.

(iv) Tasks may run sequentially, in parallel or overlapping.

(v) Gantt charts are particularly helpful ways of dealing with scheduling tasks, understanding critical paths of project and planning of resources.

Application of Gantt Chart in Project Planning:

Gantt Chart represents graphically on a time scale as to when certain operation would be performed. It is useful in recording the progress of the schedule. For example, a Gantt Chart in below figure, shows the work already completed as on today (Say on 4th Oct. 1999).

- (i) Job #P06 is complete.
- (ii) Job #P07 and #P10 are partially over.
- (iii) Job #P08 has not yet started as its starting date is 18th Oct. 1999.

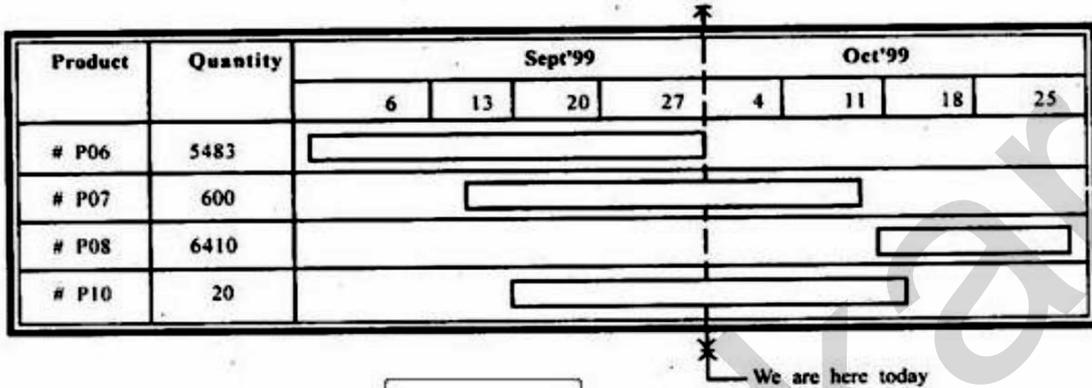


Fig. : Sample Gantt Chart indicating Production Schedule for different products

Beside this, Gantt charts are extensively used scheduling devices in the past, although many of the charts are now drawn by computer. They are used in form of Scheduling or progress charts, which depicts the sequential schedule. They are used in form of Load charts, which show the work assigned to a group of workers or machines. They are used in form of Record a chart, which are used to record the actual operating times and delays of workers and machines.

Q.2 Attempt any TWO of the following : [16]

Q.2(a) Enlist any four factors which affect selection of material handling system. Explain [8]
which type of material handling system is suitable for :

- (i) Unloading two wheelers from truck
- (ii) Stacking of pallets in store racks.

(A) Four Factors affecting Selection of Material Handling System :

- (i) Adaptability and Flexibility
- (ii) Type of Material to be handled
- (iii) Type of Layout
- (iv) Type of Production
- (v) Material flow pattern
- (vi) Load Capacity
- (vii) Speed & Power
- (viii) Space requirements
- (ix) Ease of maintenance
- (x) Environmental factors
- (xi) Cost of installation and handling

Suitable Material Handling Devices for Following Activities:

	MH Activity	Type of MH Device to be used	Reason/Remark
(i)	Unloading Two Wheelers from Truck	(1) Unit Load Devices. (2) Truck Loaders & Unloaders. (3) Storing Transfer Vehicle.	(1) Economical Material Unloading System. (2) Cuts down unloading Cost. (3) Decreasing turnaround time. (4) Require low maintenance. (5) Used with all type of truck and trailers.

(ii)	Stacking of Pallets in store racks	(1) Automated Retrieval and Storage Equipment (AS/RS) System. (2) Unit Load Storage & Retrieval System. (3) Pallet Stacking Frame.	(1) Higher/Flexible Storage Capacity. (2) Ease of Access to storage locations. (3) High Level of Information Technology. (4) Higher Inventory to be stored.
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Q.2(b) What is process planning? Explain the steps in process planning?

[8]

(A) Process planning is the systematic determination of the process by which a process is to be manufactured economically and competitively.

OR

Process planning is responsible for conversion of design data to work instruction.

It consists of determining and specifying process, machine tools and other equipment to convert raw material in to finished product.

Explanation of following steps:

1. Preparation of working drawings.
2. Deciding to make or buy.
3. Selection of manufacturing process.
4. Machine capacity and its selection.
5. Selection of material and bill of material.
6. Selection of jig & fixture, other attachments.
7. Operational planning and tool requirements.
8. Preparation of documents such as operation & route sheets etc.

Q.2(c) How inspection stages are determined? State the significance of operation sheet.

[8]

(A) Following points taken into considerations for determine stages of inspection :

- (1) Type of production system. i.e. Job, batch or mass etc.
- (2) Nature of product i.e. complex which consist of more number of parts or simple one.
- (3) Process selected for manufacture which consist of simple or complex operations or which consist of cheap or costly operations.
- (4) Type of layout i.e. line layout or functional layout etc.
- (5) Finding the key operations in process responsible for the essential function of the product.
- (6) The cost incurred on inspection i.e. money spend on inspection and cost of allowing defective parts per lot.

Significance of operation sheet :

- (1) The operation sheet gives the information that is very vital to process engineer.
- (2) It helps the supervisor to know which operation is being performed on the job.
- (3) It helps the worker to clearly understand the drawing.
- (4) It also instructs the worker about the speed, feed and depth of cut to be used for particular operation.
- (5) It also gives the information about the time required for the operation. This can help the process engineer to schedule the similar jobs.
- (6) The information like the availability of machines can also be obtained from the operation sheet.
- (7) As the operation sheet is one of the activity in the process plan, it helps to get a systematic process plan.

Q.3 Attempt any FOUR of the following :

[16]

Q.3(a) State different types of plant layout. Explain any one type.

[4]

(A) **Types of plant layout**

There are three types of plant layout depending upon the volume of production. They are :

- (1) Line or Product layout.
- (2) Functional or Process layout.
- (3) Project or Fixed position layout.

Line or Product layout:

In this type of layout, the machine and auxiliary services are arranged in line according to sequence of operations to be performed. The raw materials enter in the line at one end, the operations are carried out in succession in a smooth flow and finished product is delivered at other end of the line. In this layout, there will be a separate production line for each type of product. Product layout is suitable for continuous production where there is a stable product demand.

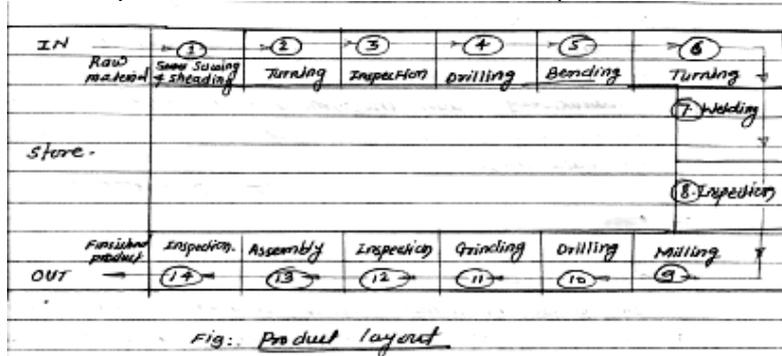


Fig.: Product layout.

Functional or Process layout:

Process layout also known as functional layout. In this layout machine performing similar operations are grouped together, and are not arranged according to any particular sequence of operations. The machine group together in different department or even different building therefore lot of cross movement of work take place. Due to this, process layout is suitable for low volume of production & where the product is not standardized.

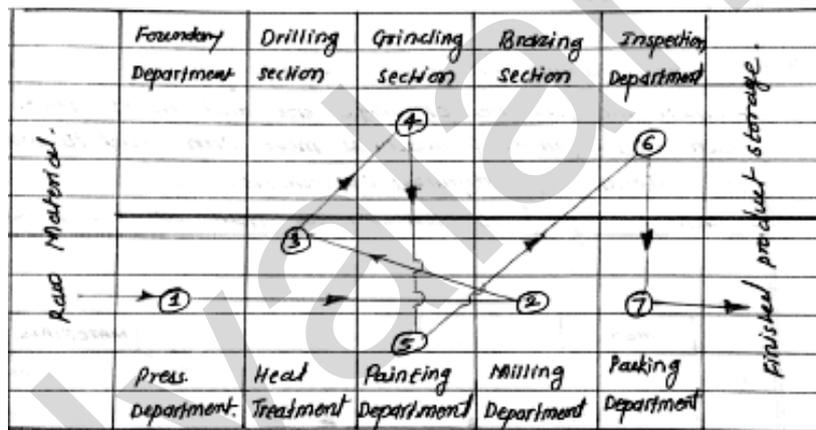
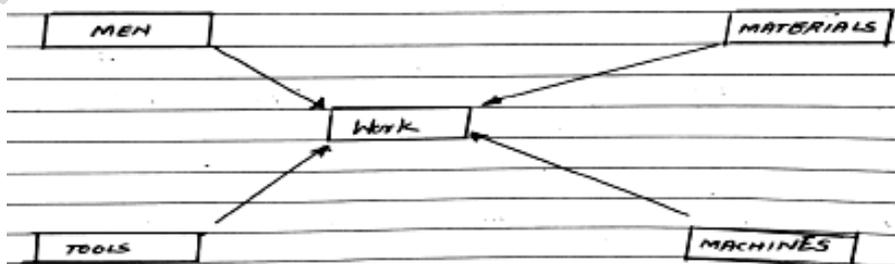


Fig: A typical process layout.

Project or Fixed layout:

When the jobs are huge size and heavy, then, in such case, men and machines move with respect to work/job to perform the required operations. Such a layout is known as static or fixed position layout. Such type of layout is typical in customer oriented type production like ship building, air craft construction, large turbo generators, etc.



Q.3(b) Explain the concept of AGV? State its any two applications. [4]

(A) AGV is the battery operated programmed vehicle, used to carry load from one location to another by following a prescribed path around the manufacturing floor. It is a driverless vehicle, which is able to select its own path to reach the destination. Human intervention is not needed for guidance, steering or control of the vehicle. Such vehicles have on-board controllers that can be programmed for complicated and varying routes as well as load and unload operations.

Applications :

- (i) AGVs are extensively used in FMS (Flexible Manufacturing System).
- (ii) AGV material handling system is very suited to computer integrated manufacturing system.

Q.3(c) State the advantages and disadvantages of combined operations. [4]

(A) Combined Operation

If the number of operations are combined in one setting it is possible to reduce the production time and the operations can be performed with more accuracy.

Advantages of combined operations :

- (i) Improved accuracy
- (ii) Reduced labour cost
- (iii) High rate of production
- (iv) Less handling required
- (v) Less scrap

Disadvantages of combined operations

- (i) Possible higher total cost.
- (ii) More costly set up.
- (iii) Trained operators are necessary.
- (iv) Sometimes special machines are needed.

Q.3(d) What is group technology? Give its applications. [4]

(A) Group technology is based on the general principle that many problems are similar and by grouping similar problems single solution can be found to a set of problems thus saving time and efforts. This principle can be applied to any branch of engineering. The group of machines are formed so that all the components in one family can be manufactured by one machine group. These machine groups can be arranged in two ways :

- (i) The group lay out system.
- (ii) The group flow line system.

In the first system the machines are arranged into groups in such a manner that each group can carry out all the machining operations needed for a family of components for e.g. A particular family of component requires machining operations on a lathe, a drilling machine, a milling machine and a lapping machine. These four machines grouped in two cells and located in one small area of the floor space.

In second, the machines are arranged in the sequence of production operations and usually linked by conveyour arrangement.

The group technology is also known as "Part Family Manufacture".

This group technology approach is used for manufacturing in automobile industry, fast food chains, doctors and dentists etc.

Q.3(e) Differentiate between Jig and Fixture.

[4]

(A)

	Jigs	Fixtures
(i)	Jigs holds and locate the work piece and also guide the cutting tool to the work.	Fixture only holds and locates the work piece and does not guide the tool.
(ii)	Jigs are movable device and generally not fixed to the machine table.	Fixtures are fixed device, usually clamped or bolted to the machine table.
(iii)	Jigs are usually lighter in construction than fixtures.	Fixtures are usually heavy in construction.
(iv)	It requires drill bushes.	It requires setting block.
(v)	Most jigs uses standard parts such as drill-bushes, dwell pins etc.	Fixtures does not use standard components.
(vi)	Jigs are used on drilling, reaming, tapping and counter boring operation.	Fixtures are used with turning, milling, grinding, shaping etc.

Q.3(f) Write any four objectives of method study.

[4]

(A) **Objectives of Method Study:**

- (i) To eliminate the unnecessary movements.
- (ii) To arrange the sequence of motions in their most efficient order.
- (iii) To improve the manufacturing processes and procedures.
- (iv) To improve the working conditions.
- (v) To improve the plant layout and work place layout.
- (vi) To reduce the human effort and fatigue.
- (vii) To reduce the material handling.
- (viii) To improve the plant and equipment design.
- (ix) To improve the utility of material, machines and manpower.
- (x) To standardize the method.
- (xi) To improve the safety standard.
- (xii) To reduce the monotony in the work.
- (xiii) To reduce the manufacturing costs through reducing cycle time of operation.

Q.4(a) Attempt any THREE of the following :

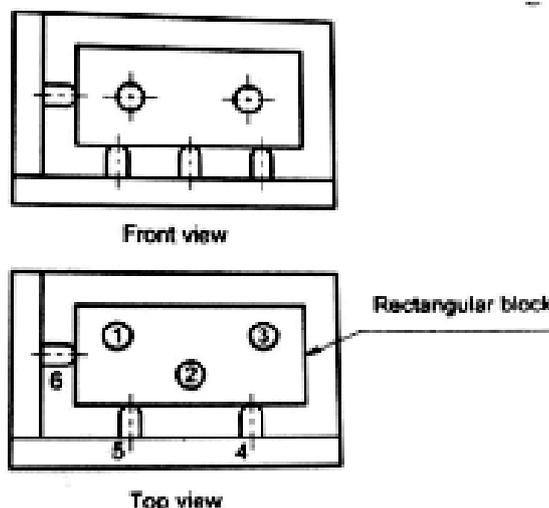
[12]

Q.4(a) (i) Describe 3 - 2 - 1 principal of location used in Jig and fixture with suitable sketches?

[4]

(A) Locating the work piece by means six points is known as the six point location method.

A work piece can be exactly located by means of six points. In this system three pins are located in the first plane, two in the second plane perpendicular to the first and one in the third plane as shown in figure.



This is known as 3-2-1 principle of location. A free body in space has 12 degrees of freedom (six rotational and six linear). Out of these 12, the six points arrest 9 freedoms of the workpiece. The remaining 3 freedoms are arrested by the clamping device.

Q.4(a) (ii) Explain the concept of ERP.

[4]

(A) Enterprise resource planning (ERP)

ERP is a business management software-usually a suite of integrated applications-that a company can use to collect, store, manage and interpret data from many business activities, including :

- Production planning, cost
- Manufacturing or service delivery
- Marketing and sales
- Inventory management
- Shipping and payment

ERP came to represent a larger whole that reflects the evolution of application integration beyond manufacturing.



ERP provides an integrated view of core business processes, often in real-time, using common databases maintained by a database management system. ERP system track business resources-cash, raw materials, production capacity-and the status of business commitments : orders, purchase orders, and payroll.

ERP (Enterprise Resource Planning) systems typically include the following characteristics :

- An integrated system that operates in (or near) real time without relying on periodic updates.
- A common database that supports all applications
- A consistent look and feel across modules

Q.4(a) (iii) Enlist any four basic components used in robotic systems also write their functions.

[4]

(A) Basic components used in robotics system with their functions:

- (i) Arm :** The arm is the part of the robot that positions the end effectors and sensors to do their pre-programmed task.
- (ii) End-effectors :** It is designed to perform the task like grasping, transporting, lifting etc. It also be used to perform operations on work piece.
- (iii) Actuator :** An actuator is a device that produces translatory or rotary movement of the links or makes the freedom possible. These are the drives for the manipulator, which connects the controller with manipulator.
- (iv) Sensors :** They convert one form of energy into another for useful purpose. They perform two major tasks. One is to collect information about the different links, arms with their status and other one is to inform controller about outside environment.
- (v) Controller :** Controller coordinates the movement of the arm. The controller receives the input data from the computer, controls the actuator motion and takes the feedback information through various sensors.
- (vi) Drive :** The drive is the engine or motor that moves the links into their designated positions.

Q.4(a)(iv) Explain the importance of '5S' ("Five S") concept.

[4]

(A) Introduction of 5S Concept:

- (i) 5S is a process of workplace organization and housekeeping which is carried out gradually and systematically.
- (ii) It is a structured program to implement workplace organization and standardization.
- (iii) A well organised workplace motivates people, both on the shop floor as well as others.
- (iv) 5S improves safety, work efficiency and productivity.
- (v) Five S is an integrated Japanese concept for proper housekeeping and they call it as "Workplace Management". According to Japanese, effective work place management calls for five steps also known as pillars of 5S, Viz.

	Parameter	Japanese Term	Meaning
(i)	1 st S	SEIRI	Organizing (Sorting)
(ii)	2 nd S	SEITON	Neatness (Simplify)
(iii)	3 rd S	SEISO	Cleaning (Sweep)
(iv)	4 th S	SEIKETSU	Standardization
(v)	5 th S	SHITSUKE	Self Discipline (Sustain)

Importance of '5S' ("Five S") Concept:

- (i) It is the silent informer of a Company's attitude to quality.
 - (ii) It is symbol of Team work.
 - (iii) It is useful for Marketing a Product.
 - (iv) It improves the quality of human behavior.
- In fact, 5S is a basic step in a journey towards Total Quality Management (TQM).

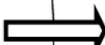
Q.4(b) Attempt any ONE of the following :

[6]

Q.4(b) (i) Construct two handed process chart for the assembly of Nut and Bolt with summary.

[6]

- (A)
- Task : Assembly of Nut and Bolt.
 - Chart begins : Both hands free before task.
 - Chart ends : Both hands free after task.
 - Charted by : -----
 - Date of Charting : -----

Left Hand		Right Hand	
Description	Symbol	Symbol	Description
Nut to the workstation			Bolt to the workstation
Position nut on bolt			Grasp the bolt securely
Thread nut			Hold the bolt
Inspect			Hold
To the bin			Transfer assembly to left hand
Drop the assembly to bin			Wait

Symbol	○	⇒	□	▽	D
Frequency (L.H.)	3	2	1	---	---
Frequency (R. H.)	2	1	---	2	1

Q.4(b) (ii) If a worker takes 15 minutes as a standard time for a job in which total allowances is 20% of normal time, If the rating of worker is 100%. Find the actual time required by worker. [6]

(A) Standard time = normal time + allowances
 Allowances = 20% of normal time

$$ST = NT + \text{allowances}$$

$$ST = NT + 20\% NT$$

$$= NT(1 + 0.2) = 1.2 NT$$

$$ST = 15 \text{ min}$$

So,

$$NT = \frac{15}{1.2} = 12.5 \text{ min}$$

$$NT = \text{Actual time} \times (\text{rating factor})$$

$$= 100\% \times AT \quad (AT = NT)$$

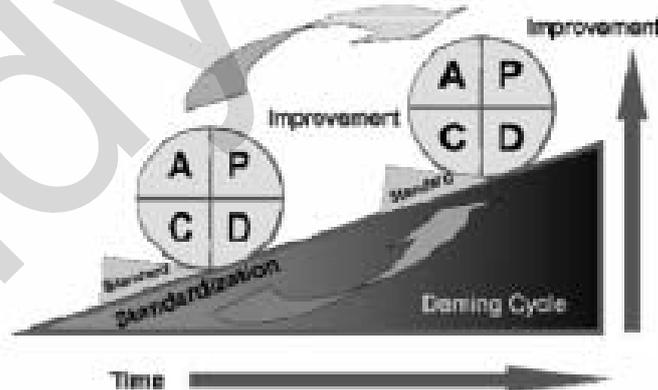
$$AT = NT = 12.5 \text{ min}$$

Q.5 Attempt any FOUR of the following : [16]

Q.5(a) Explain the cycle of Kaizen activity. [4]

(A) Cycle of Kaizen activity

Dr. J. Edward Deming, the famous quality guru, provided a simple yet highly effective technique that serves as a practical tool to carry out continuous improvement in the workplace. This technique is called PDCA Cycle or simply Deming Cycle. PDCA is acronym of Plan, Do, Check and Action. Deming Cycle provides conceptual as well as practical framework while carrying out Kaizen activities by the employees. Let's understand the concept with following illustration :



The four steps Plan, Do, Check and Action should be repeated over time to ensure continuous learning and improvements in a function, product or process.

For example if employees want to improve either of the above areas, they should ask themselves about following question during the PLANNING phase of this cycle :

- (i) What are we trying to accomplish?
- (ii) What changes can we make that will result in improvement?
- (iii) How will we know that a change is an improvement?

PLAN stage involves analyzing the current situation, gathering data, and developing ways to make improvements.

The DO stage involves testing alternatives experimentally in a laboratory establishing a pilot process, or trying it out with small number of customers.

The CHECK stage requires determining whether the trial or process is working as intended, whether any revisions are needed, or whether it should be scrapped.

The ACT stage focuses on implementing the process within the organization or with its customers and suppliers.

Q.5(b) State the functions of drill bushes. State the advantages of renewable bush over other type bushes. [4]

(A) Function of Drill bushes

Slender and cantilever type cutting tools, mainly drills, usually suffer from run-out due to possible errors in the drill, sockets and drilling machine spindle and finally in the overall alignment. Such run out causes over sizing, out of roundness and surface roughening of the drilled holes. At higher speeds, this run out further increases if the drill is not geometrically symmetrical. This leads to poor product quality, breakage of the drill by bending and / or buckling. In order to avoid all this, it is necessary to have proper location and alignment of the drill on the work piece. For this purpose drill bushes are used.

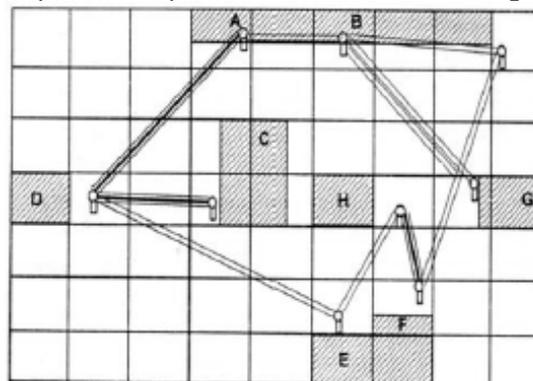
Advantages of renewable bushes over the other bushes :

- (i) These bushes are used where these bushing will wear out or become obsolete before jig, where several bushing are to be interchangeable in one hole.
- (ii) A group of holes may be drilled using a bush with required number of holes in it if they are close together to permit a bush to be used for each hole. When these holes are to be drilled, and reamed, renewable slip bushes are to be used.

Q.5(c) Explain string diagram with sketch. [4]

(A) String Diagram:

- (i) A string diagram is defined as a scale plan or model on which a thread is used to trace and measure the path of workers, materials or equipments during a specified sequence of events.
- (ii) It is a special form of flow diagram in which a string or thread is used to represent the movements.
- (iii) The purpose of using string is to measure the distance between the two movements.
- (iv) Repetitive movement and too many paths make the flow diagram congested and it becomes difficult to understand.
- (v) The paths which are travelled more frequently calls for critical examination of the work points or movement.
- (vi) A String diagram for a particular process is shown in following fig.



String Diagram

Q.5(d) Explain pull type manufacturing system.

[4]

(A) Pull Type Manufacturing System:

- (i) Just in Time (JIT) is a pull system which is also known as Make to Order Production.
- (ii) Pull System means that parts are produced to order and the production is matched with demand for the final assembly of products.
- (iii) In Make to order production system, there is a direct interaction with customers during all the stages but it is expensive during engineering phase.

Characteristics of Pull (Make to Order) Manufacturing System:

- (i) Direct interaction with customers.
- (ii) Production schedule changes with changes in customer order.
- (iii) Capacity utilization is lower.
- (iv) Capacity requirements planning are critical.
- (v) Shop floor control is critical.
- (vi) Distribution is less complicated.

Examples

Custom Tailored Clothing, Special Purpose Machinery and product made to customer specifications.

Q.5(e) Explain the basic components of Robots.

[4]

(A) Basic Components of Robots:

A Robot is a system made up of several elements of hardware and software. Robots are programmable machines with some human like capabilities. They are made up of three basic elements viz.

	Elements	Description
(i)	Mechanical Components	Provides physical robot motion and perform the various tasks. It consists: (i) A Manipulator (Base and Arm Assembly) (ii) End of arm tooling (Gripper and End effector) (iii) Actuators (Motor or drives) (iv) Transmission Elements (Belts, Pulleys, Screw & Gearing) It is used to generate necessary signals coordinate the movements of the robot. It includes;
(ii)	Control System	(i) Mechanical, Electrical, Pneumatic, Hydraulic Controls (ii) Sensors (Cameras, Amplifiers & related hardware) (iii) Equipment interface It provides the data processing capability necessary to interpolate the intermediate positions and control the movement of the links or arms of the robot. It includes;
(iii)	Computer System	(i) Microprocessor (PLC or PC's) (ii) User interfaces (Keyboard, Display, Teach Pendant) (iii) Control software to manipulate robot for various applications

Q.5(f) What are grippers? Explain vacuume actuated gripper in brief.

[4]

(A) Grippers:

A gripper is a device which enables the holding of an object to be manipulated. a gripper enables holding, tightening, handling and releasing of an object.

Vacuum Grippers:

The vacuum grippers also called vacuum cups or suction cups which uses vacuum as a gripping force. The lifting and holding is done by cups or vacuum surface driven by vacuum system. The Vacuum pump or venture system.

- (i) Usually the cups are available in round or oval shape. The common diameter size of cups is in between 30 mm to 200 mm. The selection of cup and number of cups required depends on:
- (i) Weight of the part.
 - (ii) Part size and shape.
 - (iii) Nature and type of part etc.

Sometime to increase the contact area, multiple cups are used. Vacuum cups are used to lift flat as well as curved surfaces.

Examples: Vacuum cup or Suction Cup, some vacuum grippers use a closed-cell foam rubber layer for gripping application.

Q.6 Attempt any TWO of the following : [16]

Q.6(a) Enlist the various functions of PPC. [8]

Describe : (i) Scheduling (ii) Routing in details

(A) Functions of PPC:

- Function related to material selection.
- Function related to selection of method.
- Function related to selection of machines and equipment.
- Routing. * Estimating.
- Loading. * Scheduling.
- Dispatching. * Expediting.
- Inspection. * Evaluating.

Scheduling:

- (i) Scheduling may be defined as the fixation of time and date for each operation as well as it determines the sequence of operation to be followed.
- (ii) Scheduling involves establishing the amount of work to be done and the time when each element of work will start and complete.
- (iii) The objectives of scheduling are to fulfill the delivery date promised earlier, minimize the idle time and maximize the utilization of resources.
- (iv) Scheduling is the last step in production planning. At this stage detailed plans are made which specify for each machine, the time schedule at which different products will be processed on these machines.

Routing:

- (i) Routing is the selection of route or path over which each part is to be travel during the process of transformation from raw material to finished product.
- (ii) It determines as to what work is to be done and where and how it will be done and who will do it.
- (iii) The objectives of routing are to utilize machines and men at their fullest capacity.
- (iv) Route sheet is important tool of this function which includes operation number, description of operation, machine used, tools and gauges used and standard time for any particular operation.

Q.6(b) A shop floor activity consists of three elements. Calculate the standard time for the activity. The various allowances are given as percentage of normal time. [8]

Elements	A	B	C
Observed time (min)	1.25	1.2	2.85
Rating factor (%)	90	115	85
Relaxation allowances (%)	12	13	8
Delay allowances (%)	3	6	5
Personal allowances (%)	8	6	4

(A)

Elements	Observed time	Rating	Basic Time (Normal Time)
A	1.25	90	$= 1.25 \times \left(\frac{90}{100}\right) = 1.125$
B	1.2	115	$= 1.2 \times \left(\frac{115}{100}\right) = 1.38$
C	2.85	85	$= 2.85 \times \left(\frac{85}{100}\right) = 2.4225$

Total time = 1.125 + 1.38 + 2.42 = 4.9275 Min

(i) Relaxation Allowance

$$= \left(\frac{12}{100} \times 4.9275\right) + \left(\frac{13}{100} \times 4.9275\right) + \left(\frac{8}{100} \times 4.9275\right)$$

$$= 0.5913 + 0.6405 + 0.3942 = 1.626 \text{ Min}$$

(ii) Delay Allowance

$$= \left(\frac{3}{100} \times 4.9275\right) + \left(\frac{6}{100} \times 4.9275\right) + \left(\frac{5}{100} \times 4.9275\right)$$

$$= 0.1478 + 0.2956 + 0.2463 = 0.6897 \text{ Min}$$

(iii) Personal Allowance

$$= \left(\frac{8}{100} \times 4.9275\right) + \left(\frac{6}{100} \times 4.9275\right) + \left(\frac{4}{100} \times 4.9275\right)$$

$$= 0.3942 + 0.2956 + 0.1971 = 0.8869 \text{ Min}$$

Standard Time = 4.9245 + 1.626 + 0.6897 + 0.8869 = 8.1301 Min

Q.6(c) Describe any two joint types used in robotic arm and wrist.

[8]

(A) Joint types used in robotic arm:

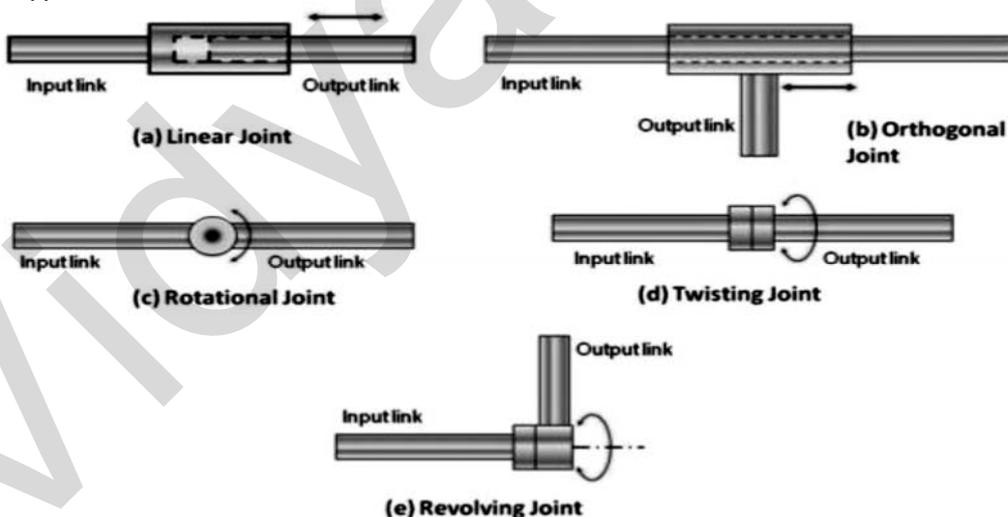


Fig.: Types of Joints

(1) Linear Joint or Prismatic joint

- The linear joint provides the translational sliding motion between the input and output link.
- The axes of the links are parallel to one another.
- The linear joint as shown in fig.(a)

(2) Orthogonal Joint

- The orthogonal joint provides the translational sliding motion between the input and output link.

- The axis of the output link is perpendicular to that of the input link.
- The orthogonal joint as shown in fig.(b)

(3) Rotational joint

- The rotational joint provides the relative rotational motion between the input and output link.
- The axis of rotation is perpendicular to the axes of input and output link.
- The rotational joint as shown in fig.(c)

(4) Twisting Joint:

- The twisting joint provides the relative twisting motion between the input and output link.
- The axis of rotation is parallel to the axes of input and output link.
- The twisting joint is shown in fig.(d)

(5) Revolving joint:

- The revolving joint provides the relative rotational motion between the input and output link.
- The axis of input link is parallel to the axis of rotation of the joint.
- The axis of output link is perpendicular to the axis of rotation of the joint.
- The revolving joint is shown in fig.(e)

