



SUMMER – 15 EXAMINATION

Subject Code: 17609 ( PE )

Model Answer

**Important Instructions to examiners:**

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

**Q1 (a)** **(Definition 1M      Stating factors 3M)**

**(i)** 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

1. Employee: quality circle, training, workers participation in decision making, promotion.
2. Process: work study, methods engineering, job evaluation, SQC.
3. PRODUCT: Product mix & promotion, standardization & simplification, value engineering etc.
4. Working conditions: occupational safety, ventilation, illumination, ergonomics.
5. Management: motivation, work culture.
6. Technology: robotics, FMS, CAE, CIMS JIT, etc.

**(ii) Define:** **(definition 1M EACH)**

- 1) **Routing:** routing lays down the flow of work in the plant. It determines what work is to be done and where and how it will be done. Taking from raw material to the finished product, routing decides the path and sequencing of operations to be performed on the job from one machine to another.



- 2) **Sequencing:** to select the order in which jobs will be processed.
- 3) **Scheduling:** to decide when the work will start and in certain duration of time how much work will be finished. It deals with the orders and machines. The aim is to schedule as large amount of work as the plant facilities can conveniently handle by maintaining free flow of material along the production line. Schedule may be called as time phase of loading.
- 4) **Dispatching:** Dispatch function executes planning function. It ensures that the plans are properly implemented. It is physical handling over of manufacturing order to the operating faculties through release of orders and instructions in accordance with previously developed plan established by scheduling department.

Q 1 (a) iii.

(STATING DESCRIPTION @ 1M EACH)

Sr no	Production system	Product	Layout	Machines	Cost of product
1	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
2	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.
3	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.



**iv) (definition 1M EACH)**

**Productivity index:** productivity index = output/input. Various sources are utilized for production like labour, raw material, machine etc. accordingly productivity is called as labour productivity , raw material productivity , machine productivity etc.

- a. **Productivity of labour** = Productivity in standard hours/actual man hours
- b. **Productivity of raw material** = numbers of units produced/material cost
- c. **Productivity of machines** = output in standard hours /actual machine hours.

**Q1 (b) (Writing any two types with sketch 3M EACH )**

(i) Material handling devices for mass production:

**Definition:** Material Handling refers to activities, equipment, and procedures related to the moving, storing, protecting and controlling of materials in a system.

**a. Containers and Unitizing Equipment**

**Containers**

- i. Pallets
- ii. Skids and Skid Boxes
- iii. Tote Pans

**Unitizers**

- i. Stretch Wraps
- ii. Palletizers

**b. Material Transport Equipment**

**Conveyors**

- i. Chute conveyors
- ii. Belt conveyors: Flat belt, Telescoping belt, Troughed belt, Magnetic belt.
- iii. Roller conveyors
- iv. Wheel conveyors
- v. Slat conveyor
- vi. Chain conveyor
- vii. Tow line conveyor
- viii. Trolley conveyor
- ix. Power and Free conveyor
- x. Cart on track conveyor
- xi. Sorting conveyor: Deflector, Push diverter, Rake puller, Moving slat, Pop-up skewed wheels, Pop-up belts, Pop-up rollers, Tilting slats, Tilt tray, Cross belt, Bombardier sorter
- xii. Powered conveyors and orienters:



- Rotary feeders
- Vibratory bowls
- Vibratory linear feeders

## **Industrial Vehicles**

### **i. Walking**

Hand truck, Hand cart, pallet jack, Walkie stacker

### **ii. Riding**

Pallet truck, Platform truck, Tractor trailer, Counter balanced lift truck, Straddle carrier, Mobile yard crane

### **iii. Automated**

Automated Guided Vehicle (AGV) [Unit load carrier, Small load carrier, Towing vehicle, Assembly vehicle, Storage/Retrieval vehicle]

Automated electrified monorail

Storing Transfer Vehicle

## **Monorails, Hoists, Cranes**

- i. Monorail
- ii. Hoist
- iii. Cranes

Jib crane, Bridge crane, Gantry crane, Tower crane, Stacker crane

## **c) Storage and Retrieval Equipment**

### **c<sub>1</sub>) Unit load storage and retrieval**

#### **i. Unit load storage**

Block stacking, Pallet stacking frame, Single deep selective rack, Double deep selective rack, Drive-in rack, Drive through rack, pallet flow rack, Push back rack, mobile rack, Cantilever rack

#### **ii. Unit load retrieval**

Walkie stacker, Counterbalance lift truck, Narrow Aisle vehicles

### **c<sub>2</sub>) Small load storage and retrieval**

#### **i. Operator-to-stock storage**

Bin shelving, Modular storage drawers in cabinets, Carton flow rack, Mezzanine, Mobile storage



ii. Operator-to-stock retrieval

Picking cart, Order picker truck, Person-aboard automated R/S machine, Robot

iii. Stock-to-operator

Carousels, Vertical lift module, Automatic dispenser

**d) Automatic Identification and Communication Equipment**

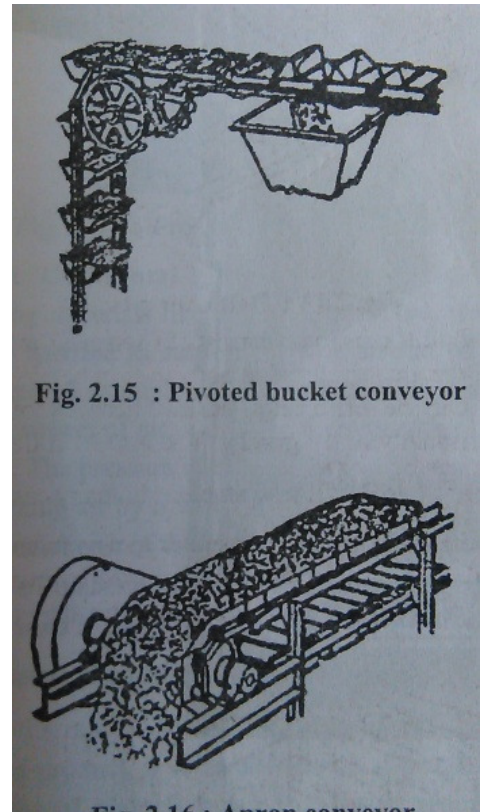
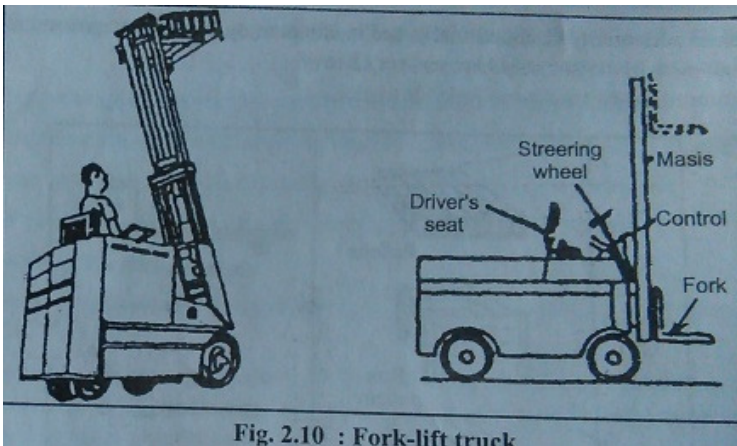
**d<sub>1</sub>) Automatic Identification and Recognition**

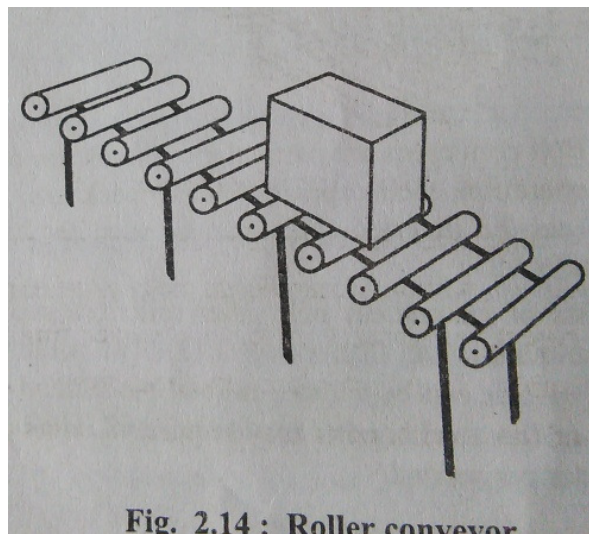
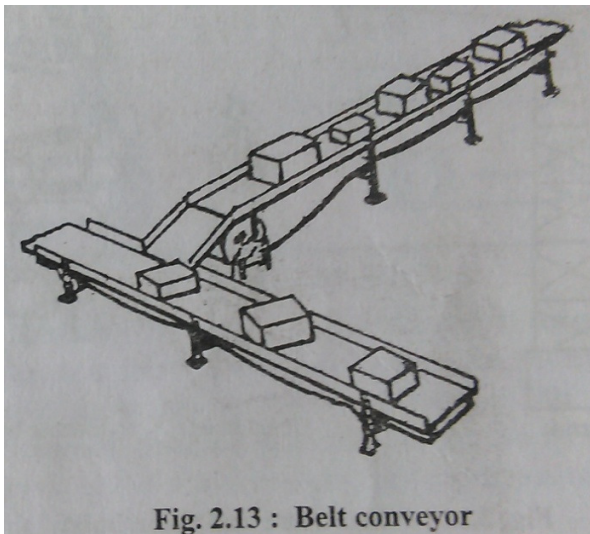
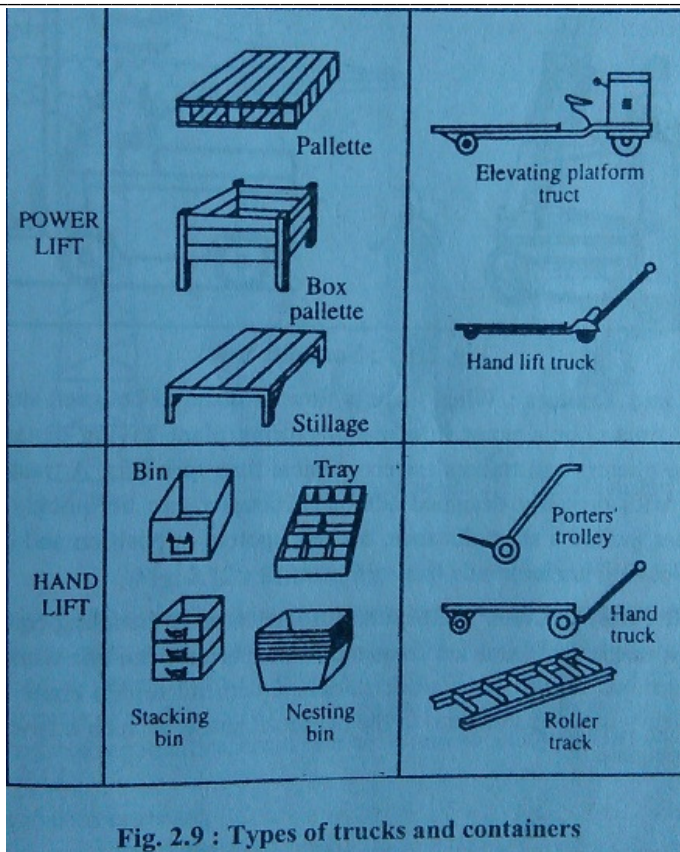
- i. Bar coding
- ii. Optical character recognition
- iii. Radio frequency tag
- iv. Magnetic strip
- v. Machine vision

**d<sub>2</sub>) Automatic, paperless communication**

- i. Radio frequency data terminal
- ii. Voice handset
- iii. Light and computer aids
- iv. Smart card

**Some sketches:**





Q1 b( ii) (definition 1M example 5 M)

**Line balancing.**

**Line balancing:** A production strategy that involves setting an intended rate of production for required materials to be manufactured within a particular time frame. In addition, effective line balancing requires assuring that every line segment's production quota can be met within the time frame using the available production capacity.





**Purpose:**

Purpose is to minimize the number of people and/or machines on an assembly line that is required to produce a given number of units.

**Example:**

Following table shows machining time for 20 different operation stages of a project.

Operation	Machine time (t min)	Preparation Time (a min)	Total operation time (T = a + t)
1	2.8	0.2	3.0
2	1.9	0.3	2.2
3	0.9	0.1	1.0
4	6.2	0.4	6.6
5	6.5	0.5	7.0
6	8.5	0.5	9.0
7	0.5	0.1	0.6
8	0.8	0.2	1.0
9	9.6	0.4	10.0
10	0.4	0.2	0.6
11	0.9	0.1	1.0
12	1.3	0.1	1.4
13	4.6	0.2	4.8
14	2.2	0.2	2.4
15	2.6	0.2	2.8
16	2.4	0.2	2.6
17	3.0	0.6	3.6
18	1.8	0.2	2.0
19	1.5	0.5	2.0
20	4.0	0.2	4.2

After careful observation of the table following are the salient points.

- Operation time differs from 0.6 minutes to 10 min. cycle time for this line is longest (10 min), if only one machine is allocated to each stage.
- Machine time at stage 9, which requires 10 min. is fully occupied, but there is idle time at all other stages. Stage 9 is bottleneck. If we want to speed up production we have to assign another machine at this stage. with two machines at this stage we can produce two units per 10 min. Time per unit is reduced to 5 min.
- Next bottleneck is stage 6, then stage 5, other stage 4 etc.
- Let we want cycle time to be 4.8 min. equal to time required at stage 13. Then number of machines required for first three stages remain at 1 machine per stage, at stage 4 we need 2 machines , 2 machines at stage 5, 2 machines at stage 6, 3 machines at stage 9 etc.
- Total number of machines required = 25. n= 20 previously. Total idle time is reduced.

Case I:

For T = 10 min, total machine time available per cycle =  $20 \times 10 = 200$  min.

Total operation time  $\{\sum(a+t)\} = 67.8$  min.



The efficiency of the cycle =  $\{\sum(a+t)\} / nt = 67.8/200 \times 100 = 33.9 \%$ .

Case II

If cycle time is reduced to 4.8 min, the efficiency of the cycle =  $67.8/(25 \times 4.8) = 56.5 \%$  and out put of the line is  $60/4.8 = 12.5$  units per hr.

Case III

If cycle time is further reduced to 3.0 min, number of machines required are 32.

The efficiency of the cycle =  $67.8/32 \times 3 = 70.6 \%$ . Output will be 20 units per hr.

**Q2 (a) (writing relaxation @1m each any four of following category ANY FOUR)**

(i) Incentives given for back ward areas:

Many incentives are provided both by the Central and State Governments to promote the growth of small-scale industries and also to protect them from the onslaught of the large-scale sector. Among the various incentives given to industries the following deserve special mention:

**1. Reservation:**

To protect the small-scale industries from the competition posed by large-scale industries, the Government has reserved the production of certain items exclusively for the small-scale sector. The number of items exclusively reserved for the small-scale sector has been considerably increased during the Five Year Plan.

**2. Preference in Government purchases:**

The Government as well as Government organisations shows preference in procuring their requirements from the small-scale sector. For instance, the Director General of Supplies and Disposals purchases 400 items exclusively from the small-scale sector. The National Small-Scale Industries Corporation assists the SSI units in obtaining a greater share of Government and defence purchases.

**3. Price preference:**

The SSI units are given price preference up to a maximum of 15 per cent in respect of certain items purchased both from small-scale and large-scale units

**4. Supply of raw materials:**

In order to ensure regular supply of raw materials, imported components and equipment's, the Government gives priority allocation to the small-scale sector as compared to the large-scale sector. Further, the Government has liberalised the import policy and streamlined the distribution of scarce raw materials.





**5. RBI's credit guarantee scheme.**

**6. Financial assistance:**

Small-scale industries are brought under the priority sector. As a result, financial assistance is provided to SSI units at concessional terms by commercial banks and other financial institutions. With a view to providing more financial assistance to the small-scale sector, several schemes have been introduced in the recent past the Small Industries Development Fund (SIDF), Window Scheme (SWS).

**7. Technical consultancy services:**

The Small Industries Development Organisation, through its network of service and branch institutes, provides technical consultancy services to SSI units. In order to provide the necessary technical input to rural industries, a Council for Advancement of Rural Technology was set up.

**8. Machinery on hire purchase basis:**

The National Small Industries Corporation (NSIC) arranges supply of machinery on hire purchase basis to SSI units, including ancillaries located in backward areas which qualify for investment subsidy. The rate of interest charged in respect of technically qualified persons and entrepreneurs coming from backward areas are less than the amount charged to others. The earnest money payable by technically qualified persons and entrepreneurs from backward areas is 10% as against 15% in other cases.

**9. Transport subsidy:**

The Transport Subsidy Scheme, 1971 envisages grant of a transport subsidy to small-scale units in selected areas to the extent of 75 % of the transport cost of raw materials which are brought into and finished goods which are taken out of the selected areas.

**10. Training facilities:**

The Entrepreneurship Development Institute of India, financial institutions, commercial banks, technical consultancy organisations, and NSIC provide training to existing and potential entrepreneurs.

**11 Marketing assistance:**

The National Small Industries Corporation (NSIC), the Small Industries Development Organisation (SIDO) and the various Export Promotion Councils help SSI units in marketing their products in the domestic as well as foreign markets. The SIDO conducts training programmes on export marketing and organises meetings and seminars on export promotion.



## **12. District Industries Centres (DICs):**

The 1977 Industrial Policy Statement introduced the concept of DICs. Accordingly a DIC is set up in each district. The DIC provides and arranges a package of assistance and facilities for credit guidance, supply of raw materials, marketing etc.

## **13. POWER :**

New industrial units with contract demand up to 100 KVA will be exempted from the payment of electricity duty for a period of 5 years from the date of availing power supply for commercial production.

## **14. Incentives for STAMP DUTY**

## **15. Tax holidays.etc**

### **Q2 (a) ii. (Writing factors (@1m each any four of following category ANY FOUR)**

Factors affecting selection of site. Explanation of any factors similar to following.

Two stages are important.

- Selection of general location.
- Selection of particular site within region.

Selection of general location

- Availability of raw material.
- Nearness to market.
- Transport facility.
- Availability of manpower.
- Suitable climatic conditions.
- Availability of labour
- Availability of water.
- Business facilities.
- Community attitude
- Legal aspects etc.

Selection of particular site within region

After deciding general location actual site within region is fixed.

- Availability of cheap land.
- Topography of land.



- Cost of laying water supply lines.
- Cast of transport.
- Availability of related industries nearby. Etc.

**Q2 (b)**

**(Definition 2M Writing steps 6M)**

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.

**Q2 (c).**

**(Writing factors (@1M any four, differentiation 4 M)**

Factors determining stages of inspection: factors similar to following points should be considered.

1. Cost of product
2. Size of product
3. Size of testing equipment
4. Quality policy of company
5. Cost of raw material to be processes
6. Availability of inspection facilities in company.



7. Preciseness of product intended
8. The accuracy of manufacturing expected

Sr no	Floor Inspection	Centralized Inspection
1	Inspector walks around the floor from machine to machine checks the sample.	The work is brought at intervals to check
2	Helps catching errors during process.	Inspection is undertaken after group of operations.
3	Material handling is not increased	Material handling is increased
4	Smaller down time due to inspection	Larger down time due to inspection
5	Production cycle is small	Production cycle is large
6	Suitable for to inspect huge jobs	Not suitable to inspect huge jobs

**3. Attempt any four of the following**

**a) Explain the concept of AGV? State it's any two applications.**

Ans: - 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:-**

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

**b) State the advantages and disadvantages of combined operations.**

And:- 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:-**

**(For 2 marks)**

- 1) Improved accuracy
- 2) Reduced labour cost



- 3) High rate of production
- 4) Less handling required
- 5) Less scrap

**Disadvantages of combined operations:-**

**(For 2 marks)**

- 1) Possible higher total cost
- 2) More costly set up
- 3) Trained operators are necessary
- 4) Sometimes special machines are needed

**C) Explain the importance of operation sheet . how it will help to improve process planning**

Ans: - **Importance** of operation sheet

**(For 2 marks)**

\*Operation sheet provide the detailed record of different operation needed to produce a part in a tabular. In short it is also known as analysis sheet, instructional sheet or process design sheet.

\* It provide the all the operations which is carried out on the raw materials and also the sequence of that.

\* the operation sheet also gives the standard time required for complete the job on desired machine.

Improve process planning

**(For 2 marks)**

\* as once different operation needed and standard time required to complete the job is known then we can plan process planning for job.

\*if there is difference between time required for actual job manufacture and standard job then we have to work in such a way that the actual job time and standard job time as close as possible.

\* Once the standard time for job is known then we can do sequencing in such a way that the idle time of machine is zero.

**d) What is group technology? Give its applications.**

Ans: 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: **(For 2 marks)**

a) The group lay out system

b) 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 conveyor arrangement.



The Group technology is also known as “Part Family Manufacture”

(For 2 marks)

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

**e) What allowances are considered while calculating standard time? (one mark each)**

Ans: - following types of allowances are considered while calculating standard time.

- 1) Relaxation allowance
  - a) Personal need allowance
  - b) Fatigue allowance
    - i) Basic fatigue allowance
    - ii) Variable fatigue allowance
- 2) Contingency allowance
- 3) Special allowance
- 4) Process allowance
- 5) Interference allowance

**f) State the principles of jigs and fixture design.**

(For 4 marks)

Ans :- General principals of jigs and fixture design are as follows :-

- 1) **Rigidity**:- a jig or a fixture should be strong enough to withstand the cutting forces that are generated during the process of machining a job
- 2) **Clearance between jigs and component**:- there should be sufficient clearance between the jig and the component for two reasons
  - i) to allow for any variations
  - ii) to allow for hand movements
- 3) **Locating points and supports**:- the locating and supporting surfaces should be definite, simple, cleanable, and wherever possible be removed
- 4) **Easy loading and unloading of the work** :- the process of loading and unloading the component should be as easy as possible quick, simple and positive.
- 5) **Clamping** :- clamping should always be arranged directly above the points supporting the work, otherwise the distortion of the work can occur
- 6) **Foolproofing**:- as the jigs and the fixtures are used mostly by unskilled workers they should be designed in such manner that the job is always loaded in its correct position inside the jig or a fixture so that, there is no chance for the worker to make mistake in loading.
- 7) **Design for safety**:- the parts of fixture that are to revolve during its working should be well guarded and all sharp corners of jigs or fixture should be rounded off.
- 8) **Ejectors** :- ejector is a device which forces the work piece out from the jig or a fixture. use of ejecting devices is particularly important when :-
  - The work piece is heavy.





4. a) attempt any three of the following

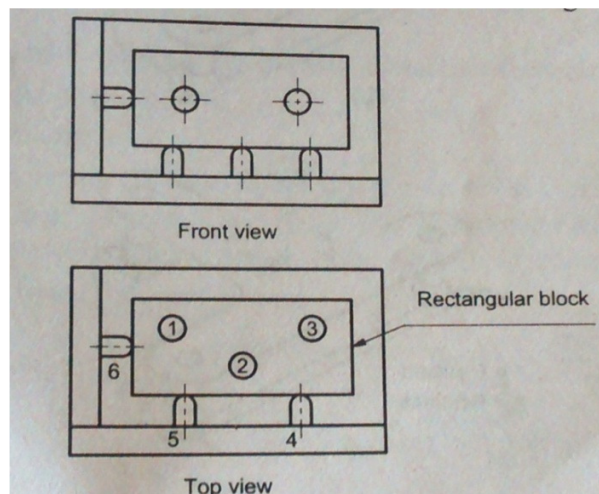
i) Describe 3-2-1 principal of location used in jig and fixture with suitable sketches?

Ans:- Locating the work piece by means six points is known as the six point location method.

(Sketch 2 marks, explanation 2 marks)

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 fig.



This is known as 3-2-1 principle of location. A free body in space has 12 degrees of freedom. ( six rotational & 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.

ii) How '5s' can be used as inventory reduction technique?

Ans:-By applying 5S in industry to systematically results—

(For 4 marks)

- Total organization, cleanliness and standardization in work piece.
- Well organized workplace.
- More efficient workplace.
- More productive operation in workplace.
- Boost the morale of the workers.
- Proud feel to worker in their receptive work.
- Realization of responsibility to worker in workplace.

Terms associated with 5S are as follows:

1. SEIRI means segregation
2. SEITON means systematic arrangement
3. SEISO means getting rid of waste & making cleanliness



4. SEIKETSU means standardizing
5. SHITSUKE means self discipline

**iii) What is end effector? Give its classification**

**Ans:-** In robotics, an end effector is a device or tool that's connected to the end of a robot arm where the hand would be. The end effector is the part of the robot that interacts with the environment. The structure of an end effector and the nature of the programming and hardware that drives it depend on the task the robot will be performing. Depending upon the application special grippers are required to be designed. **(For 2 marks)**

**Classification:-**

**(For 2 marks)**

- i) Mechanical clamping
- ii) Magnetic clamping
- iii) Vacuum (suction) gripping

**iv) What is concept of ERP? State its any two advantages**

**Ans: -** ERP (Enterprise Resource Planning) is a software architecture that facilitates the flow of information among different functions of an enterprise. **(For 2 marks)**

ERP is a game plan for planning and monitoring all of the resources of a manufacturing company including the functions of

- |                  |                |
|------------------|----------------|
| a) manufacturing | b) marketing   |
| c) finance       | d) engineering |

ERP is recognized as an effective management system. It has following benefit:

- a) It has an excellent planning and scheduling capability. **(For 2 marks)**
- b) It offers significant gains in productivity
- c) It results in dramatic increase in customer service
- d) Enables much higher inventory turns, and
- e) Greater reduction material costs

**4. b) attempt any one of the following**

- i) 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 the worker.



**Ans: -**

Standard time = normal time + allowances

Allowances = 20% of normal time

ST = NT + allowances

ST = NT + 20% NT

$$= NT (1 + 0.2) = 1.2 NT \quad ST = 15 \text{ min} \quad \text{(For 2 marks)}$$

So,

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

NT = Actual time x (rating factor) = 100 % x AT    AT = NT

$$AT = NT = 12.5 \text{ min} \quad \text{(For 2 marks)}$$

**ii) Illustrate how just in time manufacturing system is helpful to industry for reduction in inventory.**

**Ans: -** JIT manufacturing has resulted in quality, productivity and efficiency, improved communication and decrease in cost and wastes **(For 4 marks)**

- Just-in-time production is defined as a “philosophy that focuses attention on eliminating waste by purchase or manufacturing just enough of the right items just in time
- The primary elements of zero inventories (synonym to JIT ) are :
  - i) to have only the required inventory when needed.
  - ii) to improve quality to zero effects
  - iii) to reduce lead times by reducing set-up times, queue lengths and lot sizes
  - iv) to incrementally revise the operations themselves, and to accomplish these things at minimum cost
- The concept of JIT is extended to the whole system of production i.e. ,
  - i) to produce and deliver finished goods just in time to be sold
  - ii) sub-assemblies just in time to be assembled into finished goods,
  - iii) fabricated parts just in time to go into the sub-assemblies, and
  - iv) purchased materials just in time to be transformed into fabricated parts
- The JIT stands for producing necessary units in necessary quantities at the necessary time. The ultimate aim of JIT is to concentrate on lotless, repetitive manufacturing, with only one unit of work-in-process and no stock of finished goods inventories.
- Just-In-Time (JIT) refers to production and supply of required number of parts when needed

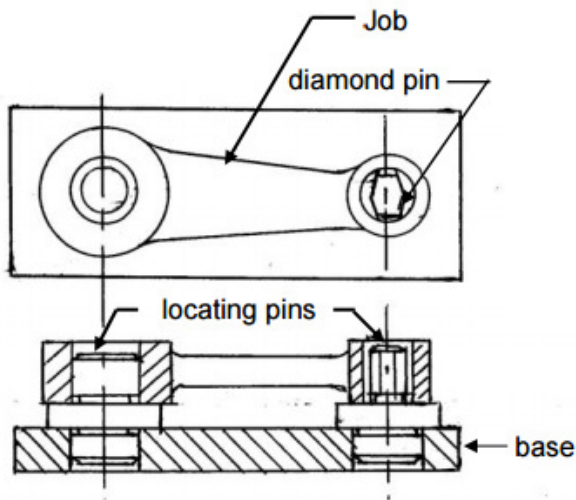
**Q. 5 Attempt any four of the following**

a) **Types of Locators:** Flat, cylindrical, diamond pin, conical, Vee Locators,

(1 M)

**Function of Diamond pin locator:** In most of the cases the work pieces are located by pre-machined ( drilled, bored or pierced ) holes such as – Locating by two holes as shown in Fig. where one of the pins has to be diamond shaped to accommodate tolerance on the distance between the holes and their diameters.

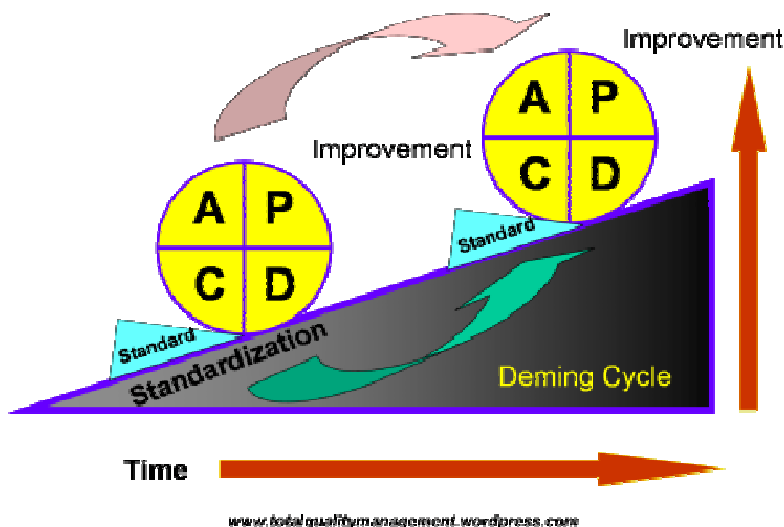
(1 M)



(2 M)

b) **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:

(4 M)



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:

1. What are we trying to accomplish?
2. What changes can we make that will result in improvement?
3. 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.

c) **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. **(2 M)**

**Advantages of renewable bushes over the other bushes:** **(2 M)**

1. 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.
2. 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.

d) **Non-contact sensors:** **(2 M)**

Non-contact sensors are solid-state electronic devices that create an energy field or beam and react to a disturbance in that field. Some characteristics of non-contact sensors:

- No physical contact is required
- No moving parts to jam, wear, or break (therefore less maintenance)
- Generally operate faster
- Greater application flexibility

Photoelectric, inductive, capacitive and ultrasonic sensors are non-contact technologies. Because there is no physical contact, the potential for wear is eliminated, however, there are some rare circumstances where there could be interaction between the sensor and target material. Non-contact sensors can also be susceptible to energy radiated by other devices or processes.

**Applications:**

**(2 M)**

- 1) Counting the number products passed across a process. e.g. In an automotive industry, a non-contact sensor counts how many have left the painting area and how many have moved on to the curing area.
- 2) Separating the defective jobs from jobs produced. e.g. if jobs produced are of different materials and colors, then they can be detected by means of colour sensor.

**e) Actuator used for discrete step mechanical movement in robot:**

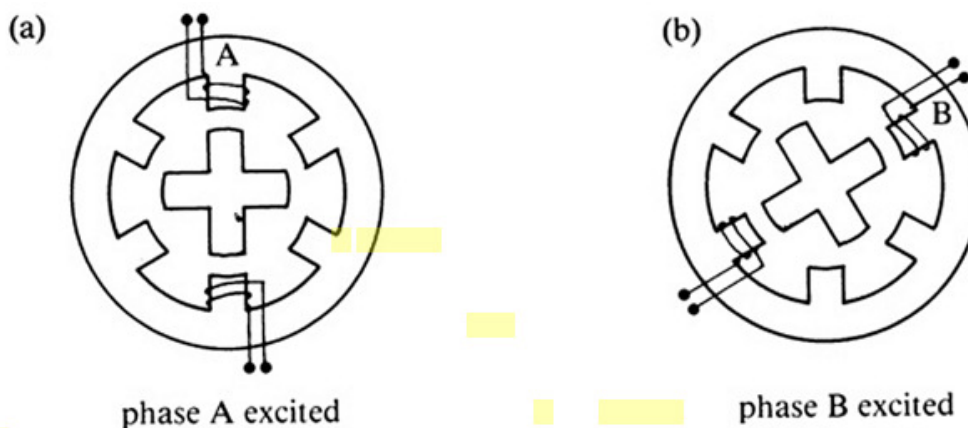
**(1 M)**

A stepper motor is used to drive in discrete steps so that it comes to rest between successive steps, or coils currents can be switched at an increasing rate so that motor accelerates, speed increasing by a definite amount at each step until some desired speed is reached, when coil switching rate is kept constant. Then stepper motor acts like a synchronous motor.

As its name implies, the stepper motor does not rotate in a continuous fashion like a conventional DC motor but moves in discrete "Steps" or "Increments", with the angle of each rotational movement or step dependant upon the number of stator poles and rotor teeth the stepper motor has.

Because of their discrete step operation, stepper motors can easily be rotated a finite fraction of a rotation at a time, such as 1.8, 3.6, 7.5 degrees etc. So for example, let's assume that a stepper motor completes one full revolution ( $360^\circ$ ) in exactly 100 steps.

Then the step angle for the motor is given as  $360 \text{ degrees}/100 \text{ steps} = 3.6 \text{ degrees per step}$ . This value is commonly known as the stepper motors **Step Angle**.



The principle of permanent magnet stepper motor operation.

**(1 M)**

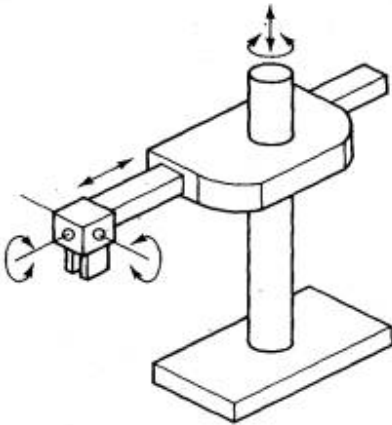
Fig. shows a principle of stepper motor. The rotor is a set of permanent magnets or iron cores in the variable reluctance motor. A two pole permanent magnet rotor is shown with six pole, three phase rotor (real motor has many more poles). When any coil is energized the rotor has one stable position. In fig 'a' coil A is energized when it is turned off and coil B is turned on, the stable position changes and the rotor rotates to align with it. There are several sets of poles associated with phase A, alternating round the circumference with the poles of other phases. In this way a small step angle can be achieved.

**(2 M)**





**f) Cylindrical configuration robot:**



In this configuration, the robot body is a vertical column the swivels about vertical axes. The arm consists of several orthogonal slides which allow the arm to be moved up and down and in and out with respect to the body. This is illustrated schematically as shown in fig.

**Applications:**

**(2 M)**

- Small robots: precision small assembly tasks
- Large robots: material handling, machine loading/unloading.

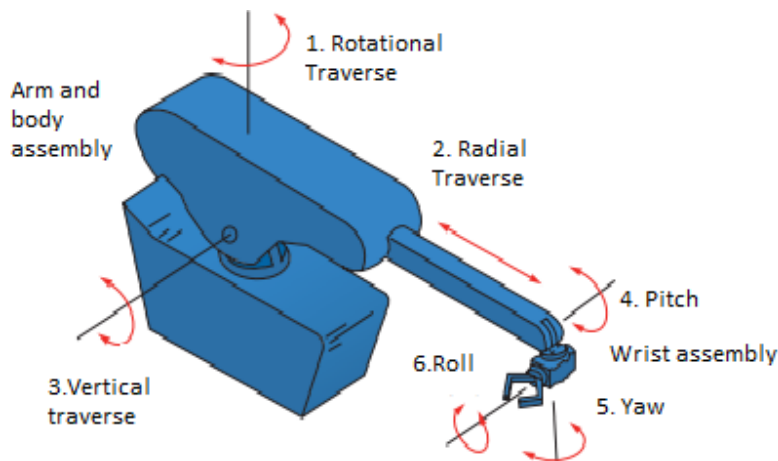
**Q. 6 Attempt any Two of the following**

**a) Degree of freedom in robot:**

**(2 M)**

These are the basic motions which provide the robot with the capability to move the end effectors through the required sequence of motions. They are intended to emulate the versatility of movement possessed by human being.

Fig shows six degrees of freedom of a robot include six basic motions three arm and body motions and three wrist motions as illustrated in polar type of robot-



**(2 M)**

Arm and body motions:

1. Rotational traverse: Rotation about vertical axis (Left or right swivel)
2. Radial traverse: Extension or retraction of the arm (in or out movement)

Vertical traverse: up and down motion of the arm

**(2 M)**

Wrist motions:

4. Pitching: up and down movement of the arm
5. Yawing: right or left swivel of the wrist

Rolling: Rotation of the wrist

**(2 M)**



**b) Gantt chart:**

**(4 M)**

A Gantt chart is "the earliest and best known type of control chart especially designed to show graphically the relationship between planned performance and actual performance." However, it is important to note that Gantt created many different types of charts that represented different views of a manufacturing system and measured different quantities.

Gantt (1903) describes two types of "balances": the man's record, which shows what each worker should do and did do, and the daily balance of work, which shows the amount of work to be done and the amount that is done. Gantt's examples of these balances apply to orders that will require many days to complete.

**Importance:**

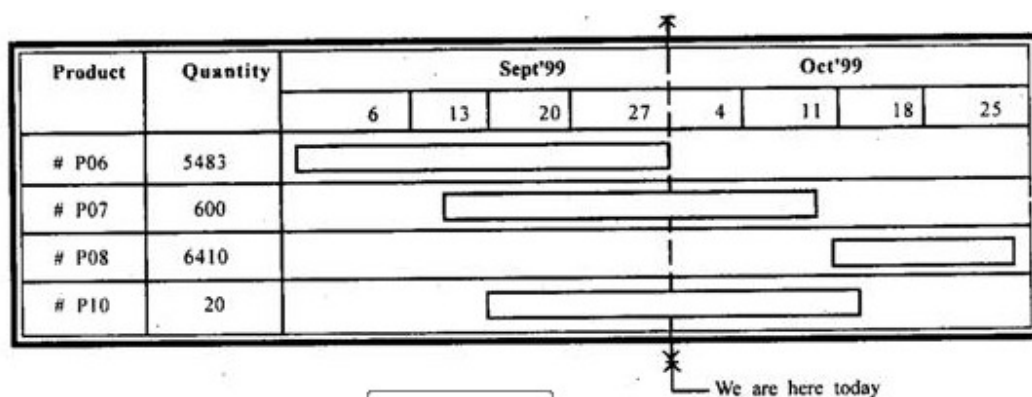
**(2 M)**

Gantt designed his charts so that foremen or other supervisors could quickly know whether production was on schedule, ahead of schedule, or behind schedule. Modern project management software includes this critical function even now. Gantt (1919) gives two principles for his charts: 1. Measure activities by the amount of time needed to complete them; 2. The space on the chart can be used to represent the amount of the activity that should have been done in that time.

**Application in PPC:**

**(2 M)**

It represents graphically on a time scale as to when certain operation would be performed. It is also useful in recording the progress of the schedule. For example, a Gantt Chart in figure below shows the work already completed as on today (say on 4th Oct. 1999). Job # P06 is complete; jobs # P07 and # P 10 are partially over. Job # P08 has not yet started as its starting date is 18th October 1999.



A typical Gantt Chart indicating production schedule for different products

**C) Process chart in data recording:**

**(1 M each = 2 M)**

Process charts are used to record the data systematically so that none of the information needed for study and analysis is missed. Depending on the situation, the following charts are used as recording technique.

A. Chart indicating process sequence: Outline process chart, Flow process chart, Two hand process chart

B. Chart using a time scale: Multiple activity chart, Simo chart

**Importance with suitable example:**

**(4 M)**



An **outline process chart** records major operations and inspections only, while a **flow process chart** records operations, inspections, transportations, storages and delays, for the activities recorded for men or materials or machines. A **two-hand process chart** records the activities of a worker's hands or limbs in relation to one another.

A **multiple activity chart** shows the activities of more than one subject recorded on a common time scale to show their interrelationship. A **simo** chart records simultaneously on a common time scale therbligs or groups of therbligs performed by different body parts of one or more workers based on frame-by-frame analysis of a cine film.

Outline (Operation) Process Chart		Name of Company	
Name and Description of assembly	Drawing No	Sketch	
	Order No		
Charted by:	Date:	Method	
		Existing	<input checked="" type="checkbox"/> Improved
<p>Legend: ○ Operations □ Inspections</p>			
Summary			
	Existing	Improved	Saving
No. of Operations			
No. of Inspections			

Example: Outline process chart:

( 2 M)