Q. 1	(A)		
	a)		1 Mark each
	b)	**The relaxations provided for back ward areas to promote rapid industrial growth are** 1) Subsidies on water, land, electricity etc. 2) Concession on various taxes. 3) Lower rate of interest on loans. 4) Promotion or benefits of different govt. schemes 5) Relaxation on sales tax	01 mark each on above or similar points
	c)	**Eight important steps for planning a process for a product from raw material to finished product are as below.** 1) Analysis of product specification and drawings. 2) Make or buy decision. 3) Selection of basic manufacturing process. 4) Determine the sequence of operations. 5) Combine the operations. 6) Selection of machine, tools, equipments etc. 7) Prepare bill of material. 8) Determine time standards.	½ mark each for above
	d)	**Johnsons rule is a technique that can be used to minimize the completion time for a group of jobs that are to be processed on two machines or at two successive work centers.** 1) All jobs are to be listed and the processing time of each machine is to be noted. 2) Select the job with shortest processing time. 3) Once the job is scheduled go to step 4. 4) Repeat step 2 and step 3 to the remaining jobs, working towards the center of the sequence.	1 marks each for above steps.

	Job Production	**Mass Production**
Product	Non Standard	Standard (Identical)
Machines	General Purpose	Special Purpose
Layout	Process	Product
Example	Jigs, Fixtures or Similar types	Automotive, TV's or Similar Types

Q. 1	**(B)**	**Given data** Fixed cost (F_c)=5,00,000 Variable cost (V_c) =1,000/article Selling price (S_p) = 2,000/article i) $BEP = \frac{Fc}{Sp - Vc} = \frac{5,00,000}{2000 - 1000} = 500 units$ ii) If Sp is reduced by 10 % then Sp new = 1800 $BEPnew = \frac{5,00,000}{1800 - 1000} = 625 units$ iii) Revenue at new BEP 625 X 1800 = 11,25,000 If 500 articles are sold then 500X1800=9,00,000 it is loss of (11,25,000-9,00,000)=22,500.	02 marks 02 marks 02 marks
Q. 1	**b.**	Production control may be defined as the direction and coordination of material and facilities towards the attainment of production goals in to the most efficient available way. Expediting: It is logical step after dispatching. It keeps close observation on the progress of the work. PPC department keeps close look whether everything is progressing according to the plan. Chasing other department heads on daily basis to keep plan on track. They update order wise completed tasks on the Time and action calendar. When they find something is going to be late they expedite and create an alarm about the delay. Definition of production control - 02 Marks Expediting - 04 Marks	
Q. 2	**a)**	**Process layout** – In process layout all similar machines are grouped together. For example all lathes grouped together in turning section. Drilling machines are grouped together in drilling section. So there are different sections or shops. Process layout is used in job or batch production.	1 Mark

		 **Advantages** : 1. Flexibility in equipment or man power allotment. 2. Better equipment utilization. 3. Comparatively low investment. 4. Diversity of tasks can be offered. 5. Load distribution can be controlled particularly during breakdown. **Limitations :** 1. Long flow lines. 2. Large amount of WIP. 3. PPC is complicated. 4. Pace of production is low. 5. High investments in machines.	1 Mark 03 Marks 03 Marks
Q. 2	**b)**	**Given data** D=3600 units/year, Co= Rs 80, Cn= Rs 1.2 $EOQ = \sqrt{\frac{2DCo}{Cn}} = \sqrt{\frac{2 \times 3600 \times 80}{1 \cdot 2}}$ $Q = 693 units$ Total minimum annual inventory cost. $Tc = \sqrt{2DCoCn}$ $= \sqrt{2 \times 3600 \times 80 \times 1 \cdot 2}$ $Tc = Rs.832$ Optimum No. of orders per year $N = \frac{D}{Q} = \frac{3600}{693} = 5.19 \cong 6 order / year$ Optimum period of supply per order	02 Marks for each

		$T = \frac{1}{N} = \frac{1}{5.19} = 0.1925$	
Q.2	**c)**	Calculate basic time for element separately using $BasicTime = \frac{ObservedTime \times ObservedRating}{S\tan dardRatinng}$ Element I $BT = \frac{0.4 \times 85}{100} = 0.34 \min$ Similarity for Element II 1.28 min, Element III 0.90 Min, Element IV 2.04 min. Total Basic time =(0.34+1.28+0.90+2.04) = 4.56 min Total allowances 15 + 2 = 17 % of basic time Standard time = Basic time + Allowances =4.56 +(17% of 4.56) =4.56 + 0.7752 Standard Time = 5.33 min	1 Marks 4 Marks 1 mark 2 mark

Q.3	**a)**	**Work study & Ergonomics are means for higher productivity...** There are certain means to increase productivity such as reducing machining time, cutting down non-productive time, less time in change of tools, improved tooling, good training, less movement of jobs, use of good technology, etc. **Work study** is a generic term for the techniques of method study and work measurement. These techniques are used in the examination of human work in all its contexts. They lead systematically to the investigation of all the factors which affect the efficiency and economy at the work place in order to affect improvement. It is important technique applied for increasing productivity and considered as a valuable tool. Its objectives are 1. Improvement of manufacturing processes and procedures. 2. Improvement of working conditions. 3. Improvement of plant layout and work place layout. 4. Reducing the human effort and fatigue. 5. Reducing material handling 6. Improvement of plant and equipment design. 7. Improvement in the utility of material, machines and manpower. 8. Standardization of method. 9. Improvement in safety standard. In short improvement in any one above leads to higher productivity. **Ergonomics** deals with application of laws governing man-machine system to the analysis and design of machines to enhance human (operator) efficiency. One need to know about ergonomics if you are an employer or an employee in the manufacturing, construction, maritime, and agricultural industries and you or your employees' work activities and job conditions which include Repeating the same motion throughout your workday, Working in awkward or stationary positions, Lifting heavy or awkward items, using excessive force to perform tasks, and being exposed to excessive vibration or extreme temperatures. It means that if the in the design of any machine a thought is given to ergonomics, it surely improves efficiency of human being. Improved efficiency is an important tool regarded for improved productivity. Hence, Work study & Ergonomics are means for higher productivity.	2 marks 2 marks
	b)	**Group Technology .... Applications** Definition: Group Technology or GT is a manufacturing technique in which the parts having similarities in Geometry, manufacturing process and/or functions are assembled together. GT is based on a general principle that many problems are similar and by grouping similar problems, a single solution can be found to a set of problems, thus saving time and effort. The group of similar parts is known as part family and the group of machineries used to process an individual part family is known as machine	

		cell. It is not necessary for each part of a part family to be processed by every machine of corresponding machine cell. This type of manufacturing in which a part family is produced by a machine cell is known as cellular manufacturing. The manufacturing efficiencies are generally increased by employing GT because the required operations may be confined to only a small cell and thus avoiding the need for transportation of in-process parts. The principle of group technology is to divide the manufacturing facility into small groups or cells of machines. The term cellular manufacturing is often used in this regard. Each of these cells is dedicated to a specified family or set of part types. Typically, a cell is a small group of machines (as a rule of thumb not more than five). An example would be a machining center with inspection and monitoring devices, tool and Part Storage, a robot for part handling, and the associated control hardware. GT can produce considerable improvements where it is appropriate and the basic idea can be utilized in all manufacturing environments. **Application:** Auto industry, Machining center, any other suitable application (**03 marks for explanation & 01 mark for application)**	
	c)	**Principles of Jigs/Fixtures (any eight) (Each for ½ marks)** Important principles Common to jigs and fixtures are explained in the following way. There are some principles which are useful to design jigs and fixtures. 1: Rigidity: 2: Easy loading and unloading of work piece: 3: Clearance: 4: easy disposal of chips: 5: Ejectors: 6: Inserts: 7: Design for Safety: 9: Simplicity in design: 10: Economical:	
	d)	**Enlist Information Contents in Operation sheet (any 4,one mark for each)** The diagram which shows operation sequence of machining as the principal process operations is a Op. sheet. It should have following information • Name of machines • Tools required (special & general purpose) • Capability of equipments • M/c load charts • Standard data related to cycle time • Details of operation	

e) SEISO & SHITSUKE (Explanation 1 mark & Example 1 mark)

5S is the name of a workplace organization method that uses a list of five Japanese words: seiri, seiton, seiso, seiketsu, and shitsuke. Translated into English, they all start with the letter "S". The list describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order. The decision-making process usually comes from a dialogue about standardization, which builds understanding among employees of how they should do the work.

Japanese Term	English Equivalent	Meaning in Japanese Context
Seiri	Tidiness	Throw away all rubbish and unrelated materials in the workplace
Seiton	Orderliness	Set everything in proper place for quick retrieval and storage
Seiso	Cleanliness	Clean the workplace; everyone should be a janitor
Seiketsu	Standardization	Standardize the way of maintaining cleanliness
Shitsuke	Discipline	Practice 'Five S' daily - make it a way of life; this also means 'commitment'

SEISO: Cleanliness or Sweeping or Shining

Standardized cleaning-point at a 5S organized plant. Clean the workspace and all equipment, and keep it clean, tidy and organized. At the end of each shift, clean the work area and be sure everything is restored to its place. This makes it easy to know what goes where and ensures that everything is where it belongs.

Example: Cleaning m/c workplace before & at the end of job each time

SHITSUKE: Discipline or Sustaining the Practice

Maintain and review standards. Once the previous 4 S's have been established, they become the new way to operate. Maintain focus on this new way and do not allow a gradual decline back to the old ways. While thinking about the new way, also be thinking about yet better ways. When an issue arises such as a suggested improvement, a new way of working, a new tool or a new output requirement, review the first 4 S's and make changes as appropriate.

Example: Keeping time or keeping uniform or any other suitable example

Q.4. (A)

a) How 5 S can be used in waste management techniques...

In lean manufacturing, waste is defined as anything that does not add value. This means that waste includes not only material waste but also such things as time and motion. Following are main forms of waste:

- Overproduction.
- Over-processing.
- Transportation.
- Inventory.
- Waiting time.
- Motion.
- Correction.

In all above lean manufacturing wastes management, focus is on various aspects like reducing inventory, reducing waiting time, minimize defects, reducing unnecessary production of items, re-doing / repairing, etc.

5 s methodologies have the objectives include mainly the following aspects:

Throw away all rubbish and unrelated materials in the workplace

Set everything in proper place for quick retrieval and storage

Clean the workplace; everyone should be a janitor

Standardize the way of maintaining cleanliness

Practice 'Five S' daily - make it a way of life; this also means 'commitment'

Applying 5s methodology to organization would result on similar lines in order to eliminate waste.

So, 5S can be used as waste management technique.
(four marks for suitable answer)

b) Two types of assembly systems ...Explain any one

Assembly systems are of following two types **(1 mark)**

- Stationery assembly system
- Progressive assembly system

Stationery Assembly Systems**:** **(3 Marks)**

This assembly system refers to the use of various devices and tools to perform the different assembly tasks at a fixed place on the major component. All other components are moved to this place and assembly performed on the major job.

A method of producing this assembly, tools for supporting a major component consists of the steps:

- Determining the predetermined positions and orientations in space at which the component should be supported
- Designing a jigs/fixture frame to provide support at predetermined locations of the frame for different positions
- Constructing various fixtures frames
- Constructing pick-up devices having a receiving element for carrying the component
- Mounting the pick-up devices to the fixture frame at the predetermined locations; and moving each receiving element about/around the orthogonal axes to align the receiving element with a respective predetermined position and orientation.

Examples are assembly systems used in Jet planes, Ships, Heavy/large duty equipments.

c) Plant efficiency & Machine Capacity

Plant efficiency: (2 Marks)

It is the ratio of actual o/p of the plant in terms of standard machine hours to total available machine hours.

It can also be defined as the ratio of actual o/p of the plant in terms of standard man hours to total available man hours

Example : A plant having 25 machines is having 200 machine hours available in a shift of 8 hours. If it gives output equivalent of 160 hours in one shift, it means efficiency is 160/200 hrs. i.e. 80%

Machine capacity: (2 Marks)

It is defined as the number of pieces that can be produced through one machine for a given period of time.

Example: M/c capacity of CNC Lathe is 1200 Items /day

d) Line Balancing

Definition: A production strategy that involves setting an intended rate of production for required materials to be fabricated 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. With a line balance you define a planned production rate for a demand program of several materials, which you would like to produce in a certain period. In addition, you guarantee that the average work content of each line segment can be carried out in the processing time available from the capacity available. The planned production quantities (rates) determine a planned total time. The planned total time is the period in which a material enters and leaves the production line. Since the work content varies in each line segment, in the line balance you can change the allocation of operations to the line segment in such a way that the average work content can be carried out in the working time available. In addition, you can change the amount of total and individual capacities in a line segment that you have defined in the line hierarchy. These adjustments are only valid for the respective version of the line balance. In this way you can adjust the capacity of the production line, which you have designed in the line hierarchy for a maximum load, for every version of the line balance or for every period. The following graphic shows the connection between the line hierarchy and the capacity adjustment in the line balance. If necessary, you can carry out a line balance for every period. Therefore the line balance has versions with defined validity periods. A line balance version consists of the planned production rates of the demand program and of the reference to the assigned rate routings. In the line balance you can change the allocation of operations. The line balance contains evaluations concerning, for example, the execution time of the materials.	
Q.4. (B)	**a)**	**Procedure to find final capacity of m/c or std. machine running time** Standard Machine running time is the time during which a machine is actually operating. That means it is machine time minus any machine down time, machine idle time, machine ancillary time. **Procedure :** Under the assumptions of standard spindle speed, feed, depth of cut and all other operating parameters following procedure may be carried out. A job cycle time is inclusive of online inspection time, loading and unloading times, tool change, etc. - First calculate machine ancillary & setting time = say T_1 hrs - Consider Machine idle time = say T_2 hrs - Consider Machine down time = say T_3 hrs - Find out job cycle time (which should include various activity times) = say T_4 hrs	

		- Consider a batch of say, N no. of jobs Then, Capacity of machine or Standard Machine running time $T = T_1 + T_2 + T_3 + (T_4 \times N)$ Hrs In this way Capacity of machine or Standard Machine running time can be calculated.	
	b)	**Classify material handling equipments ... types.. uses (1 mark each)** Material handling equipments are of different types such as Storage and handling equipment, Engineered systems, and Industrial trucks, Bulk material handling, On-Rails Transfer Cart and Conveyors. The equipments can be further sub classified into: 1. Pure Hoisting Machineries o Jack o Winches o Hand Hoists o Pulley Blocks 2. Cranes o EOT Crane o Jib Crane o Cantilever Crane 3. Elevators o Lift o Bucket Elevators 4. Conveyers: Belt , Hydraulic, Pneumatic, Apron, Screw, Flight are conveyer subtypes. 5. Surface equipments: Trucks, Lorries, railways, Wagons, Forklifts, Overhead rails, Scrapers are some types. Uses: All the above systems are used for material and goods handling depending upon requirements.	
Q.5 a.	**Following are the Characteristics of Lean Manufacturing System (any eight ,Each ½ mark)** 1. Just-in-time inventory systems and lean staffing that minimize production buffers 2. Rapid machine setups to permit small production runs by reducing changeover times 3. Use of work teams on the production line 4. Extensive training to develop multi skilled workers 5. Job rotation to facilitate on-the-job learning of multiple tasks and skills		

6. Off-line problem solving or quality circle groups that involve employees in continuous improvement activities
7. Integrated single piece continuous workflow
8. Quick changeovers of machines and equipment allow different products to be produced with one-piece flow in small batches
9. Layout is based on product flow
10. Active involvement by workers in trouble shooting and problem solving to improve quality and eliminate wastes.

b. **The Method Study consists of the following eight steps (Each ½ mark)**

1. Select - the work to be studied
2. Record - all relevant information about that work
3. Examine – all the recorded information
4. Develop - an alternative or improved method which should be most efficient, practically feasible and economical viable
5. Evaluate - different alternatives to develop a new improved method
6. Define - the new method, so developed with all its intricate details
7. Install - the new method as standard practice
8. Maintain - the new method and take the steps necessary to keep the standard practice

c. **Following Therbligs with symbol are used (any four, Each for 1 mark)**

d. **Following are the different components of jig/fixture (Each for 1 mark)**

1. A sufficient rigid body (plate, box or frame structure) into which the work pieces are loaded
2. Locating elements
3. Clamping elements
4. Tool guiding elements (for jigs) or tool setting elements (for fixture)
5. Elements for positioning or fastening the jig or fixture on the machine on which it is used.

e. **Specimen form for Issuing materials by storekeeper (4 marks)**

MATERIAL REQUISITION

Material required for..... No.....
(Job or Process)
Department..... Date.....

Sr. No.	Description	Code No.	Quantity		Rate	Amount	Entered on store register page No.
			Demanded	Supplied			
Requisitioned by		Approved by		Material Issued by		Received by	

Material Issue Requisition form.

f. **Following are the objectives of a Material Requirement Planning system**

1. to maintain the least inventory required to adequately meet the job requirements
2. to guarantee the finished products can be produced and delivered in a timely manner
3. to efficiently purchasing of new stock , plan the daily manufacturing, and deliver finished products to flow without interruption or incident
4. It focuses on having all components available at right place in right quantity at right time. **(one mark for each or similar point)**

Q.6.a) **Following are the types of locating devices (Any four)(each for ½ mark)**

1. Locating Pins
   i. Conical ii. Diamond iii. Cylindrical iv. Cylindrical flange
2. Support Pins
   i. Fixed type ii. Adjustable type
3. Radial or Angular location
4. Bush location
5. V – location

Following are the types of Clamping devices (Any four) (each for ½ mark)

1. Clamping screws
2. Hook bolt clamp
3. Lever type clam
4. Quick acting clamp

b) **Characteristics of Single Piece Production System (Any four) (each for 1 mark)**

1. Each job order is different from the previous as regards its type, specification, quality and quantity.
2. Product design takes a lot of time.
3. Prior planning becomes difficult.
4. General purpose machines are preferred.
5. High degree of control is essential.
6. The rate of production is less.
7. Process layout is used.
8. Material handling is more.
9. Work in process inventory is more.
10. The cost of the product is high.
11. Meet specific customer requirements.

c) **Work sampling** is a widely used basic industrial engineering technique to find the percentage occurrence of a certain activity by statistical sampling and random observations. **(1 mark)**

Advantages (any one) (1 mark)

1. Many operators or activities which are difficult or uneconomical to measure by time study can readily be measured by work sampling.
2. A work sampling study may be interrupted at any time without affecting the results
3. No stopwatch or other time measuring device is needed for work sampling studies
4. Work sampling studies are preferred to continuous time study by the operators being studied.
5. Work sampling studies are less fatiguing and less tedious to make on the part of time study engineer.
6. It usually requires fewer man-hours to make a work sampling study than to make a continuous time study

Disadvantages (any one) (1 mark)

1. Work sampling study does not provide elemental time data.
2. Compared to stop watch time study, the statistical approach of work sampling study is difficult to understand by workers.
3. The operator may change his work pattern when he sees the study person.
4. Work-sampling study may be uneconomical for studying operators or machines located over wide areas.

Applications(any one) (1 mark)

1. Determine the time spent by each worker or machine on productive or nonproductive activities such as delays or interruptions during working hours; and
2. Establish a standard time for each manual task or operation. The standard time can be used for manpower planning, work distribution, production planning, and costing, among others.

d)

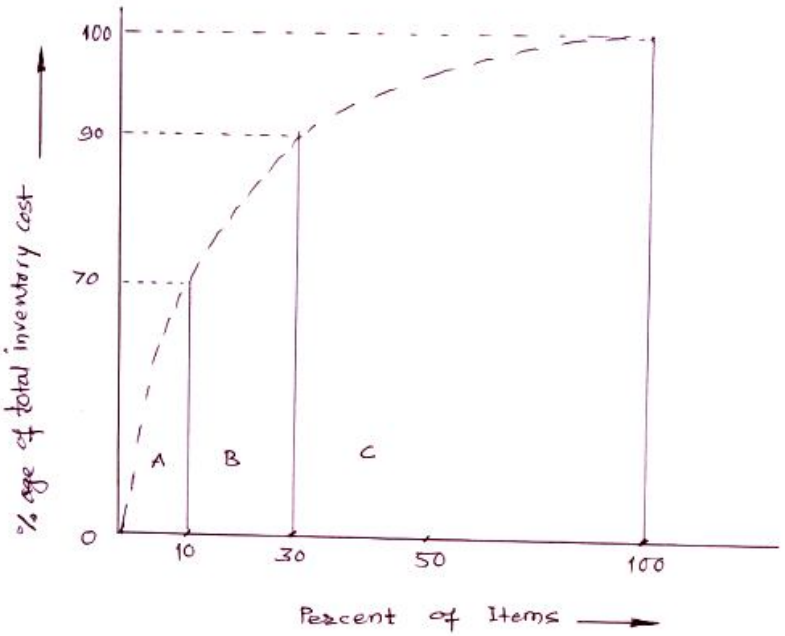
ABC Analysis

The **ABC analysis** is a business term used to define an inventory categorization technique often used in materials management.

The ABC analysis provides a mechanism for identifying items that will have a significant impact on overall inventory cost.

The ABC analysis suggests that inventories of an organization are not of equal value. Thus, the inventory is grouped into three categories (**A, B, and C**) in order of their estimated importance.

- **A ITEMS:** very tight control and accurate records
- **B ITEMS**: less tightly controlled and good records
- **C ITEMS**: simplest controls possible and minimal records



It is seen from graph that, A-Items are high valued but are limited or few in number. They need careful and close inventory control. Minimum and maximum limit and reorder point is set for A- Items. A Items generally account for 70 – 80 % of the total inventory cost and they constitute about 10 % of total items.

B- Items are medium valued and their number lies in between A and C- items. Such items need moderate control. They are more important than C-Items. These items about 20 to 15 % of total inventory cost and constitute about 15 to 20 % of the total items.

C-Items are low valued but maximum numbered items. These items do not need any control, rather controlling them is uneconomical. These are the least important items like clips, pins, washers, rubber bands, stationary etc.

C – Items generally accounts 10 to 5 % of the total inventory cost and they constitute about 75% of the total items.

e)