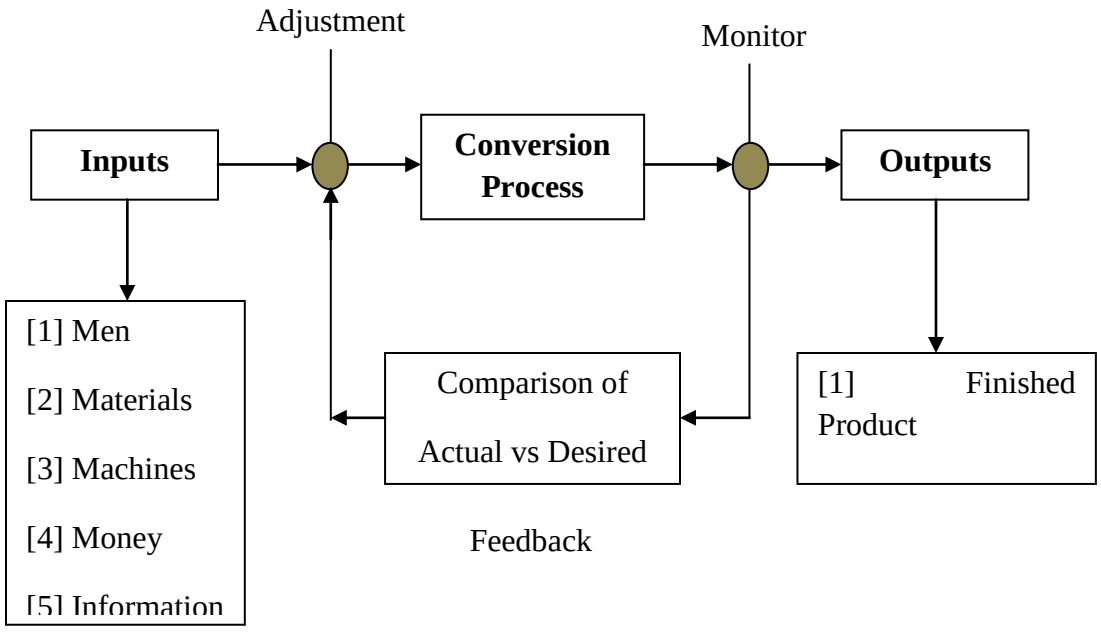
Important Instructions to examiners:

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 judgement 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.

QNo	Su.Q	Answer Key/Particulars	Marks
1	a	**Attempt Any THREE of the following:**	**(3 x 4)**
1(a)	(i)	**Define Productivity. Explain labor productivity with example.**	
		Definition of Productivity: Productivity may be defined as the ratio between output and input used in production process. Output means the amount produced or the number of items produced and inputs are the various resources employed, e.g. land, building, equipment, machinery, materials, labor etc. Productivity is an overall measure of the ability to produce a good or service. It is relates with the efficiency of a machine Production. $\text{Productivity} = \frac{\text{Output Value}}{\text{Input Value}}$ **Labor Productivity:** It is indicated by units of output per labor hour or unit of output per shift. (Units/Hour) It is defined as value added per labor. It reflects the effectiveness and efficiency of labor in the production and sale of the output. $\text{Labor Productivity} = \frac{\text{Units of Outputs}}{\text{Human Inputs (Labor Hour)}}$ Labor Productivity can be measured in terms of money or in terms of man hours. [1] In terms of Money it can be measured as,	2 Marks for Definition of Productivity 1 Mark for Definition of Labor

		Labor Productivity = Total Production Revenue / Labor Expenditure **Example for Case 1:** If the company produced the Total Production Revenue as an output of Rs. 10,000/- for a particular time period, and the human (Labor) input of that company (Total Labor Expenditure) is Rs. 3000/- then the labor productivity in terms of money, is calculated as; Labor Productivity (LP) = Total Production Revenue (Output) /Labor Expenditure (Input) LP = 10000 /3000 = 3.333 [2] In terms of man hours, it can be calculated as, Labor Productivity = Production in standard hours / Actual man hours **Example for Case 2:** If the company which processes fruits and vegetables is able to produce 400 cases of canned peaches in one half hour with four workers, then the labor productivity in terms of man hours, is calculated as; Labor Productivity (LP) = Quantity Produced/Labor Hours LP = 400 cases / (4 Workers x ½ hours/worker) LP = 400/2 LP = 200 cases per Labor hour.	Productivity 1 Mark for suitable example of Labor Productivity
1 (a)	**(ii)**	**Explain the concept of production system with proper input output model.**	
		Concept of Production System: The Production System of any organization is that part which produces the organizations products. [1] Production is the basic activity of any organization and all the other activities revolve around production activity. [2] The output of production is the criteria of goods of services, which satisfy the	2 Mark for Concept of Production System

		needs of the customer. [3] The production system of an organization is that part, which produces products of an organization. [4] It is that activity whereby resources, flowing within a defined system, are combined and transformed in a controlled manner to add value in accordance with the policies communicated by management.  **Figure: Input-Output Model of Production System** A simplified Production System with Input-Output Model is shown in above figure. [1] In this, Men, materials, machineries, money etc, are the part of Inputs of the system. [2] The finished goods and services are the outputs of the system through the different conversion processes like product design, process and production planning and control, maintenance etc. [3] The inputs are processed by a service of operations in a predetermined sequence. [4] Also there is a feedback system about the activities, which is essential to control and improve system performance.	1 Mark for Input Output Model of Production System 1 Mark for explanation
1 (a)	**(iii)**	**Compare Job and Batch production system with respect to:** **(1) Equipments** **(3) Investment** **(2) Labor** **(4) Examples of Products.**	
		Difference between Job and Batch Production System with respect to following	

parameters:

S. No.	Parameters	Job Production	Batch Production
1	**Equipments**	Used General Purpose Machines	Used Robots and CNC Machines with Automation
2	**Investment**	GPM are used so, Less initial investment in plant & machinery	More investment in machines as the set up needs to changed for each lot
3	**Labor**	Highly skilled operators required who can take up each job as a challenge because of uniqueness	Labors must be skilled in specific operations to arrange the similar set up when the batch is repeated
4	**Examples of Products**	Aircrafts, Ships, Space vehicle, Bridge and Dam, Special Car Manufacturers, Railway and Locomotives	Books, Clothing and certain industrial machinery, Chemical plants, Pharmaceuticals, Paints, Machine Tools, Pumps, Compressors, I C Engine etc.

1 Mark for each parameter

1 (a) (iv) What is line balancing? Why it is necessary?

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.

[1] An Assembly line can be considered as a Production sequence, where parts are assembled together to form an end product.

[2] In Assembly lines the operations are carried out at different work stations situated along the line.

[3] 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.

[4] 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.

2 Marks for Concept of Line Balancing

Necessity/Requirement of Line Balancing:

[1] To distribute the tasks evenly at every work station so that the idle time of men and machines is distributed equally.

[2] To minimize the idle time of men's and machines in line.

[3] To provide perfect balance when the assignments provide no idle time.

[4] To group the work and workers.

[5] To obtain an optimum balance of capacities on assembly line.

2 Marks for Necessity of Line

			Balancing
1	**b**	**Attempt Any ONE of the following:**	**(1 x 6)**
1 (b)	**(i)**	**Draw the layout of two wheeler service station. Justify the type of layout you have adopted.**	
		Layout of Two Wheeler Service Station: [1] The major factors considered for service station, is an impact of location on sales and services and customer satisfaction. [2] Customers usually look about how close a service facility is, particularly if the process requires considerable customer contact. [3] Hence, service facility layouts should provide for easy entrance to these facilities from the freeways. [4] Well-organized packing areas, easily accessible facilities, well designed walkways and parking areas are some of the requirements of service facility layout. [5] Service facility layout will be designed based on degree of customer contact and the service needed by a customer. [6] These service layouts follow conventional layouts as required. Considering all this parameters, in a two wheeler service station, **Product Layout** is adopted, where the activities for servicing a vehicle follows a sequence of operation irrespective of the type of vehicle. **The use of Product Layout in two wheeler service station is justified in the following circumstances:** [1] The Product layout designed according to a process separate line for each product is considered. [2] As production flow is permanently in the form of product line, automatic or special purpose machines are used. [3] A specialized team of plant maintenance staff will look after the repair and maintenance of machines. [4] A Product Layout (also called a Flow Shop Layout) is one in which equipment or work processes are arranged according to the progressive steps by which the product is made. The path for each part is, in effect, a straight line. All this parameters fulfilled by the two wheeler service station, so that the two wheeler service layout is lies in category of **Product Layout.**	4 Marks for Concept of Layout of 2 Wheeler Service Station With Suitable Justification 2 Marks for Suitable Labeled Layout (Any one type layout)

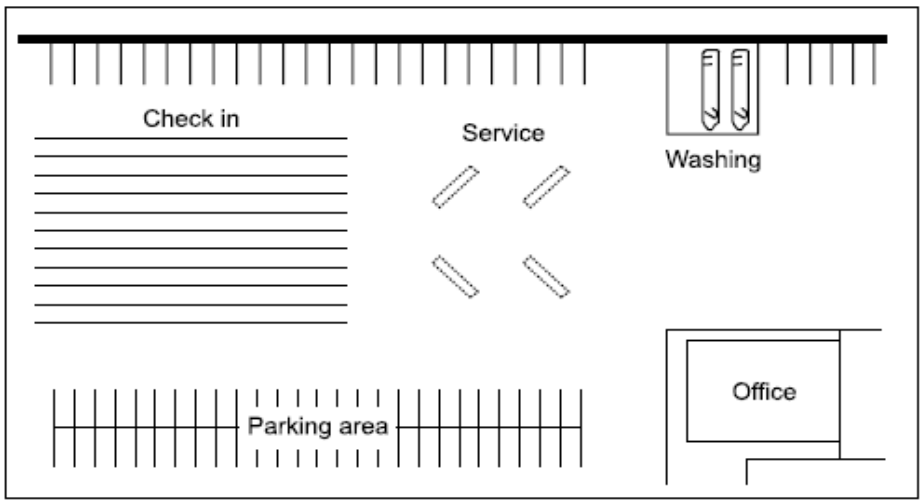


Figure: Typical Layout of Two Wheeler Service Station

(2 Marks for Concept of Layout of 2 Wheeler Service Station, 2 Marks for Justification of the statement, 2 Marks for Suitable Labeled Layout)

OR

(The two wheeler service station with Process/Functional Layout is also considerable. Examiner can consider following points with suitable sketch for Process Layout)

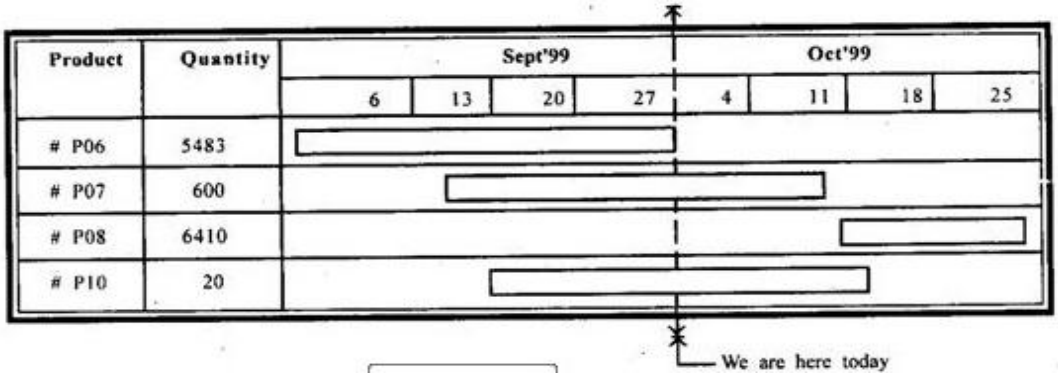
Process / Functional Layout:

1) New jobs with varying work contents and different operations sequences can be taken up without any difficulty
2) Variety of jobs makes the work interesting to the workmen
3) Imbalance of work in one section does not affect the working of the other section
4) Workers attains greater skills as they have to attend one type of machines and operations
5) Greater utilization of equipments
6) Breakdown of equipment. absenteeism of worker or non availability of certain spares does not dislocate the other activities in the service station

OR

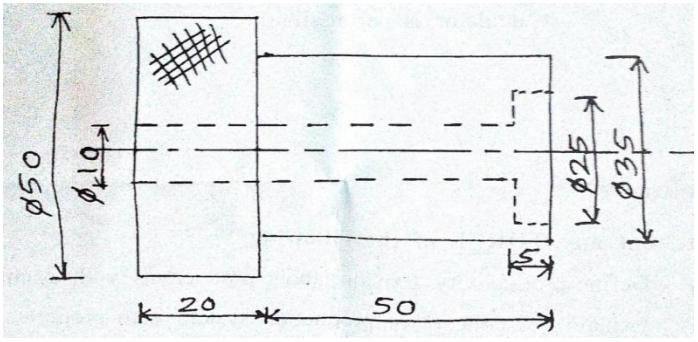
(The two wheeler service station with Combination Layout is also considerable. Examiner can consider following points with suitable sketch for Combination layout)

Combination Layout:

		It is a combination of Product and Process Layout and it is utilized generally where 1) Product contains lot many components 2) Products require to be serviced in different types and varieties The parts are serviced on facilities arranged in a process type of layout and they are assembled using product type of layout.	
1 (b)	**(ii)**	**Explain how Gantt chart is used in project planning with proper example.**	
		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 chats are simple to understand and easy to construct, they are used by most project managers for all but the most complex projects. [1] In a Gantt Chart, each task takes up on row. [2] Dates run along the top in increments of days, weeks or months, depending on the total length of the project. [3] 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. [4] Tasks may run sequentially, in parallel or overlapping. [5] 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), 1. Job #P06 is complete. 2. Job #P07 and #P10 are partially over. 3. Job #P08 has not yet started as its starting date is 18th Oct. 1999.  **Figure: Sample Gantt Chart indicating Production Schedule for different products**	3 Marks for Use of Gantt Chart in Project Planning with Example 3 Marks for Sample Gantt Chart & its Applicatio n

		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.	With sketch
2		**Attempt Any TWO of the following:**	**(2 x 8)**
2	**(a)**	**Enlist any four factors which affect selection of material handling system. Explain which type of material handling system is suitable for:** **(i) Unloading two wheelers from truck ii) Stacking of pallets in store racks.**	
		Four Factors affecting Selection of Material Handling System: [1] Adaptability and Flexibility [2] Type of Material to be handled [3] Type of Layout [4] Type of Production [5] Material flow pattern [6] Load Capacity [7] Speed & Power [8] Space requirements [9] Ease of maintenance [10] Environmental factors [11] Cost of installation and handling	Enlist any 8 Factors, each of 1/2 Marks
		Suitable Material Handling Devices for Following Activities:	2 Marks for each Activity with Suitable MH device & its proper reason

S. No.	MH Activity	Type of MH Device to be used	Reason/Remark
1	**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
2	**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

2	**(b)**	**State the information required to do process planning. What is working drawing?**	
		Information required to do process planning: [1] Assembly and Part drawings and Bill of Materials [2] Technical Details of Machine/Equipment to be used [3] Standard Times for operation [4] Availability of equipments, tools and machinery [5] Quantity of work to be done along with product specification [6] Quality of work to be complete [7] Sequence in which operations will be performed on the raw material [8] Knowledge of manufacturing processes [9] Knowledge of various tooling and fixtures [10] Names of equipments on which the operation will be performed **Significance of Working Drawing:** [1] The term working drawings (also referred to as Production Drawing) describes a set of assembly drawings and detail drawings. [2] Working drawing for machines includes assembly drawings showing how to manufacture the parts. [3] For example, weldments are types of assembly drawing showing the welds that must be used to form an assembly from separate pieces of metal. [4] An assembly drawing shows the assembly of machine or structure with all detail parts in their functional positions or as an exploded view where we relate the parts to their functional positions.	Enlist any 8 parameters , each of 1/2 Marks Significance of Working Drawing For 4 Marks
2	**(c)**	**Prepare operation process sheet and decide sequence of operation for the component shown in Figure No. 1. Assume suitable material and cutting conditions.**	
		Operation Sheet with correct sequence of operations for the above given component by assuming suitable material and cutting conditions is as shown in below table;  **Fig. No. 1, Q. No. 2 (c)**	

			S. No.	**Description of Operation**	**Machines Used**	**Tool/Fixtures Used**	**Machining Parameters**		
							Cutting Speed (m/min)	**Feed (mm/rev.)**	**Depth of Cut (mm)**
			1	Cut the blank for a length of 80 mm	Cutting Machine	Hack Saw	30	0.0025	-
			2	Clamp the blank in chuck with a projecting length of 80 mm	Centre Lathe	3 Jaw Chuck	30	0.025	-
			3	Facing operation to remove 1 mm of stock	Centre Lathe	HSS, R. H. Single Point Cutting Tool	30	0.025	-
			4	Turn Diameter of 50 mm for a length of 70 mm	Center Lathe	HSS, R. H. Single Point Cutting Tool	30	0.025	-
			5	Turn Diameter of 35 mm for a length of 50 mm	Centre Lathe	HSS, R. H. Single Point Cutting Tool	30	0.025	-
			6	Drilling hole of ϕ 10 mm at the centre for a length of 70 mm (through out)	Centre Lathe	Drill Bit	30	Medium	-
			7	Drilling hole of ϕ 25 mm at the centre for a length of 5 mm	Centre Lathe	Drill Bit	25	Medium	-
			8	Cutting Off the job at 70 mm length	Centre Lathe	Parting Tool	30	0.025	-
			9	Knurling Operation on ϕ50 mm rod for length of 20 mm	Centre Lathe	Knurling Tool with knurling wheel	25	Medium	-
									4 Marks for deciding correct sequence of operations 4 Marks for Preparing Operation sheet with
3		**Attempt Any FOUR of the following:**							**(4 x 4)**

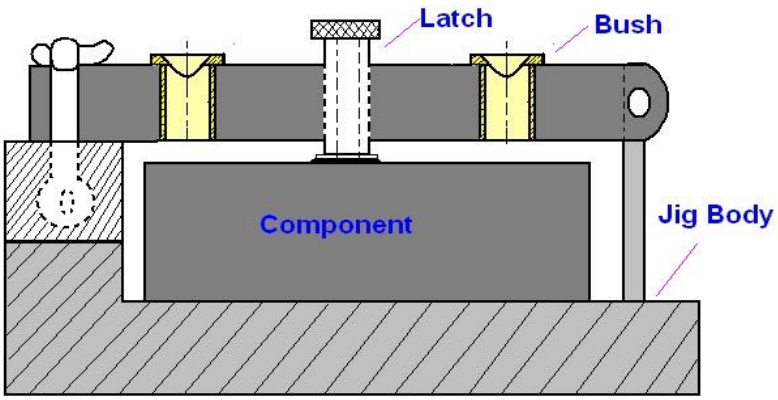
<table>
<tr><td>3</td><td>(a)</td><td>Write any one application for each of following material handling equipments:
(i) Bucket Conveyors
(ii) Fork Lift Trucks
(iii) Jib Crane
(iv) Gravity Chutes</td><td></td></tr>
<tr><td></td><td></td><td>Applications of MH Equipments:
<table>
<tr><th>S.No.</th><th>MH Equipment</th><th>Applications</th></tr>
<tr><td>1</td><td>Bucket Conveyor</td><td>[1] Useful for moving material between two fixed workstations, either continuously or intermittently.
[2] Used for movement of granular, powdered or liquid materials.
[3] Used to move bulk materials in a vertical or inclined path.</td></tr>
<tr><td>2</td><td>Fork Lift Trucks</td><td>[1] Most suitable for intermittent production and for handling various sizes and shapes of material.
[2] Used to stack material at height.</td></tr>
<tr><td>3</td><td>Jib Crane</td><td>[1] Used when the desired lifting area resides within a (semi)circular arc.
[2] Useful for the workstation arrangement and in small workshops.</td></tr>
<tr><td>4</td><td>Gravity Chutes</td><td>[1] Used to handle material between fixed points.
[2] Used to handle packages or loose items between floors.
[3] Used to provide accumulation in shipping areas.
[4] Used to link two handling devices.</td></tr>
</table></td><td>Enlist any one Application of Each, 1 Marks for each Equipment</td></tr>
<tr><td>3</td><td>(b)</td><td>Define process planning. Enlist various steps in process planning.</td><td></td></tr>
<tr><td></td><td></td><td>Definition of Process Planning:
Process planning is the system responsible for the conversion of design data in to work instruction. It is an intermediate stage between product design and manufacturing. Process planning is the functions that establish the machining processes. OR
Process planning is the systematic determination of methods by which a product is to be manufactured economically and competitively. OR
Process planning also defined as an act of preparing a detailed processing documentation for the manufacture of a piece, part or assembly.
Process planning involves determining the sequence of processing that must be used to make the finished product.
Steps involved in Process Planning:
1. Analysis of the finished part requirements as specified in the engineering design
2. Determining the sequence of operation required
3. Selecting the proper equipment to accomplish the required operations
4. Selecting the proper material for the components/parts
5. Calculating the specific operation setup times and cycle times on each machine</td><td>2 Marks for Any correct Definition of Process Planning

2 Marks for Steps</td></tr>
</table>

<table>
<tr><td></td><td></td><td>6. Documenting the established process plans
7. Communicating the manufacturing knowledge to the shop floor
8. Combining the operations to reduce production cycle
9. Inspection of tooling, gauges for proper working</td><td>involved in Process Planning</td></tr>
<tr><td>3</td><td>(c)</td><td>What are the factors to be considered to determine stages of inspection during process planning?</td><td></td></tr>
<tr><td></td><td></td><td>Factors to be considered to determine stages of Inspection during Process Planning:
1. Type of Production System
2. Type of Facility Layout
3. Type (Nature) of Product/Components
4. Type of Machines/Equipments used
5. Application of the Product/Components etc.
6. Strength/characteristics of the product</td><td>4 Marks for enlisting the all factors</td></tr>
<tr><td>3</td><td>(d)</td><td>Explain the design principles of plant layout.</td><td></td></tr>
<tr><td></td><td></td><td>Design Principles of Plant Layout:
<table>
<tr><th>S.N.</th><th>Design Principles</th><th>Description</th></tr>
<tr><td>1</td><td>Principle of Integration</td><td>All the plant facilities should be fully integrated into a single operating unit to achieve maximum efficiency and minimum cost of production.</td></tr>
<tr><td>2</td><td>Principle of Minimum Distance</td><td>Best plant layout is the one in which men and materials have to move minimum distance between operations.</td></tr>
<tr><td>3</td><td>Principle of Space Utilization</td><td>Best plant should utilize all the available space in most economic and effective manner.</td></tr>
<tr><td>4</td><td>Principle of Flow</td><td>Best plant layout is one which results in smooth and continuous flow as per the sequence of operations.</td></tr>
<tr><td>5</td><td>Principle of Flexibility</td><td>A flexible plat layout is one in which facilities can be rearranged at a minimum cost and least inconvenience.</td></tr>
<tr><td>6</td><td>Principle of Safety, Security and Satisfaction</td><td>Best plant layout is one which makes work satisfying, pleasant, convenient and safer for workers.</td></tr>
<tr><td>7</td><td>Principle of Minimum Investment</td><td>Available facilities should be utilized in an optimum manner so as to result in minimum initial capital investment.</td></tr>
</table></td><td>Enlist Any 4 Principles,

1/2 Marks for listing,

1/2 Marks for correct description of each design principle</td></tr>
<tr><td>3</td><td>(e)</td><td>Write any four objectives of method study.</td><td></td></tr>
<tr><td></td><td></td><td>Objectives of Method Study:
[1] To eliminate the unnecessary movements.
[2] To arrange the sequence of motions in their most efficient order.</td><td></td></tr>
</table>

		[3] To improve the manufacturing processes and procedures. [4] To improve the working conditions. [5] To improve the plant layout and work place layout. [6] To reduce the human effort and fatigue. [7] To reduce the material handling [8] To improve the plant and equipment design. [9] To improve the utility of material, machines and manpower. [10] To standardize the method. [11] To improve the safety standard. [12] To reduce the monotony in the work. [13] To reduce the manufacturing costs through reducing cycle time of operation.	Enlist any Eight, 1/2 Marks for each
3	**(f)**	**Draw the labeled sketch of leaf jig.**	
		Labeled Sketch of Leaf Jig:  **Leaf Jig** **Figure: Labeled Sketch of Leaf Type Jig**	3 Marks for neat Sketch 1 Mark for correct labeling
4	**a)**	**Attempt any THREE of the Following**	**(4×3=12)**
	i) Ans:	What is ejector? State its necessity in the design of jigs and fixtures. **Concept of ejector:** A device, which is used to remove the work piece from the machine after completion of operation, is known as ejector. **Necessity:** In the design of jigs and fixture , ejector are employed to eject out (remove) the work piece from close fitting locators, after the work piece has been machined. Ejector speeds up the unloading of the work piece and thus increases the production rate.	Concept of Ejector- **2M** Necessity – **2M**
	ii) Ans:	Explain the concept of KAIZEN with example. **KAIZEN:** • Kaizen means gradual, orderly, continuous improvement. It is an approach to productivity improvement.	Explanation with suitable

		• Kaizen is a daily activity where the purpose goes beyond simple productivity improvements. • Kaizen is aimed at producing more and more value with less and less wastage, attaining better working environment, and developing stable processes by standardization. • This never ending process of achieving small improvements within the company everyday is in contrast to trying to achieve breakthrough results from larger improvements once in a while. • Kaizen implementation is said to operate on the following principles: i. Human resources are the company's most important assets. ii. Success cannot be achieved by some occasional radical changes alone, but more so by incremental yet consistently arriving improvements. **iii.** Improvements must be based on statistical or quantitative study of the performance process. **Example:** A mobile manufacturing company continuously upgrades versions of operating system like android for better performance is an example of kaizen.	example – **4 M**
	iii) **Ans:**	Enlist any four basic components used in robotics systems also write their functions. Basic components used in robotics system with their functions: 1. **Arm:** The arm is the part of the robot that positions the end effectors and sensors to do their pre-programmed task. 2. **End-effectors:** It is designed to perform the task like grasping, transporting, lifting etc. It also be used to perform operations on work piece. 3. **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. 4. **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. 5. **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. 6. **Drive:** The drive is the engine or motor that moves the links into their designated positions.	List of any four componen t with their functions- **1M for each**
	iv) **Ans:**	What is lean manufacturing? State its advantages. **Lean Manufacturing:**. • Lean manufacturing can be defined as "A systematic approach to identifying and eliminating waste through continuous improvement, with the product flowing at the pull of the customer in pursuit of perfection. **Advantages of Lean manufacturing:** 1. Improvements to quality, cost and delivery. 2. Reduces those costs that are within the control. 3. Remove wasteful activities that do not contribute to a products value. 4. Decrease lead time for customer. 5. Reduced inventories for manufacturers.	Concept of lean manufactu ring – **2M** Any four advantage s – **2M**

		6. Less space required.	
4	**b**	**Attempt any one of the Following**	**(1×6=6)**
	i)	Draw two handed process chart for an activity of replacing the old battery of mobile handset.	Headings- **1 M** Body of Chart- **4M** Summary – **1 M**

Ans:

Heading of chart — **1 M**

Task: Replacing the old battery of mobile handset.
Charted by: ABC
Chart begins: Hand towards the mobile handset.
Charted at: XYZ Chart ends: Place the mobile handset at its place. Charted on: 16/04/2016

Body of Chart: — **Body of chart :2 M**

Left hand description	Symbol	Symbol	Right hand description
Idle	1	1	Towards mobile handset.
		1	Pick up handset.
Towards central position.	1	2	Towards central position.
Hold mobile handset in hand.	1	2	Remove back cover of mobile.
		3	Remove old battery.
		4	Insert new battery.
		5	Place back cover.
Place the mobile at its original position.	2	1	Switch on mobile for checking.

Summary:

					
LH	**-**	**2**	**1**	**-**	
RH	**5**	**2**	**-**	**1**	

Summary: 1 M 

ii) Describe pull type of JIT system with an example.

Ans:

1] Pull Type Manufacturing System:

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

2 M for Concept.

Characteristics of Pull (Make to Order) Manufacturing System:

1. Direct interaction with customers
2. Production schedule changes with changes in customer order
3. Capacity utilization is lower
4. Capacity requirements planning are critical
5. Shop floor control is critical
6. Distribution is less complicated

2 M for characteristics

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

2 M for Examples

5 **Attempt any FOUR of the Following** **(4×4=16**

a) Differentiate between jigs and fixtures with respect to:

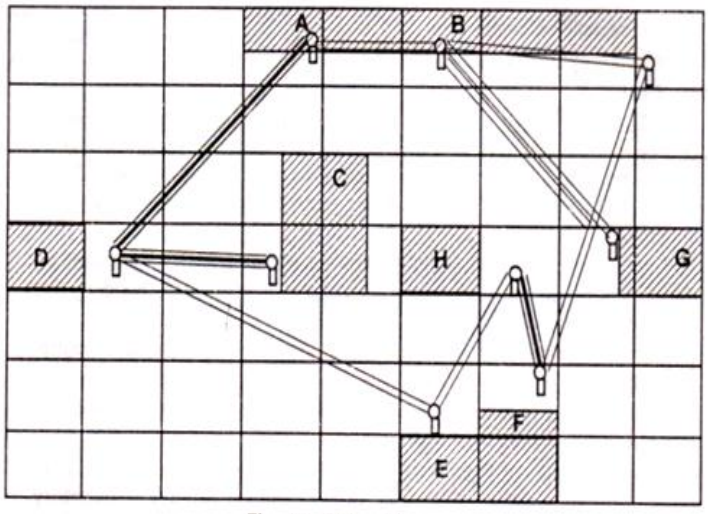
(i) Definition
(ii) Cost
(iii) Construction
(iv) Application

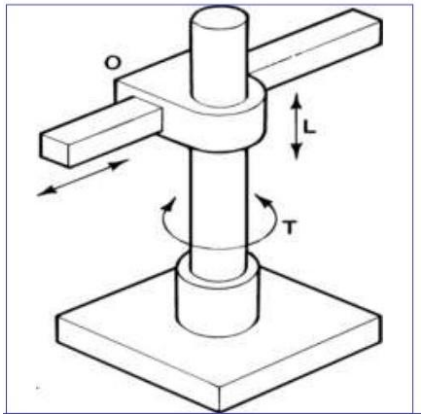
4 Points – **4 M.**

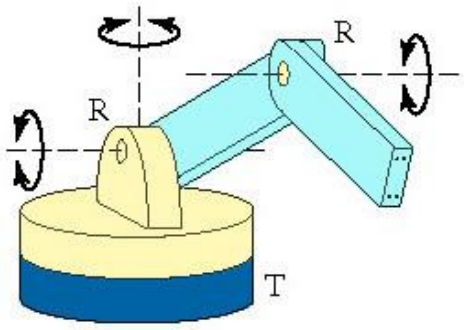
Ans:

Sr. No.	**Parameters**	**Jigs**	**Fixtures**
01	**Definition**	A jig may be defined as a device, which holds and locates a work piece as well as guides and controls one or more cutting tools	A fixture is defined as a device used for holding and locating a component or work piece securely in a definite position but it does not guide the cutting tool.

		02	**Cost**	More as compare to fixture as it includes tool guiding and holding arrangement.	Less as compare to jig.	
		03	**Construction**	Jigs are lighter in weight for quicker handling	Whereas fixtures are generally heavier in construction.	
		04	**Application**	It is used in drilling, reaming or tapping operations.	It is used for operations like milling, planing, Shaping, turning etc.	
	b) Ans:	Enlist general principle of jigs and fixture design. **Principle of jigs and fixture design:** 1. Before planning the design of a tool, compare the cost of production of the work with present tools with the expected cost of production, using the tool to be made. Confirm that the cost of building jigs & fixture is not in excess of expected gain. 2. Before lying out the jigs & fixture decide upon the location point & outline a clamping arrangement. 3. Make all clamping & building devices as quick acting as possible. 4. In selecting the location points, see that two component part of a machine can be located from corresponding points & surfaces. 5. Make the jig 'fool-proof' that means design it in such way that work cannot be inserted except in the correct way. 6. For rough casting, make some of the locating points adjustable. 7. Locate clamps so that they will be in the best position to resist the pressure of cutting tool when at work. 8. Wherever possible make all clamps, integral parts of jig or fixture. 9. Avoid complicated clamping arrangements which are liable to wear or get out of order 10. Place or clamps as nearly as possible opposite to some bearing point of the work to avoid springing. 11. Round all corners.			Any **8 Points** – **4M** **or** any 4 Points with explanation – **4M**

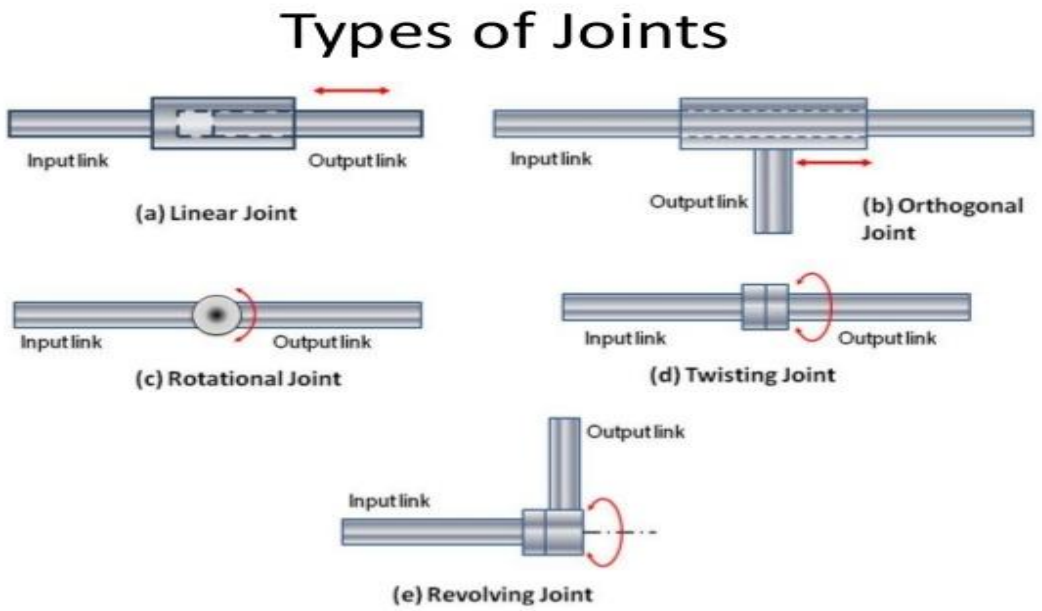
		12. Core out all unnecessary metal, making the tools as light as possible. 13. Provide feet, preferably fore, opposite all surfaces contain guide bushes in drilling and boring jigs. 14. Provide handles to make handling of jigs easier.	
	c) Ans:	Explain string diagram with sketch. **String Diagram:** 1. 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. 2. It is a special form of flow diagram in which a string or thread is used to represent the movements. 3. The purpose of using string is to measure the distance between the two movements. 4. Repetitive movement and too many paths make the flow diagram congested and it becomes difficult to understand. 5. The paths which are travelled more frequently calls for critical examination of the work points or movement. 6. A String diagram for a particular process is shown in following fig.  **String Diagram**	Explanation- **2 M** Sketch – **2 M**
	d) Ans:	Describe the vacuum actuated grippers with example. **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	Explanation with suitable example – **4M**

		system. • 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: 1. Weight of the part. 2. Part size and shape. 3. 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.	
	e) Ans:	Describe cylindrical body and arm assembly robot with neat sketch. **Cylindrical body robot:** In the cylindrical configuration, robots have one rotatory (R) joint at the base and linear (L) joints succeed to connect the links. The space in which this robot operates is cylindrical in shape, hence the name cylindrical configuration.  **Arm assembly robot:** The combination of cylindrical and articulated configurations is known as jointed arm configuration or arm assembly robot. The arm of the robot is connected to the base with a twisting joint. Rotatory joints are used to connect the links in the arm. Generally, the rotation takes place in the vertical plane. Popular robot falling under this category is called **SCARA** (Selective Compliance Assembly Robot Arm). Similar to jointed-arm robot except that vertical axes are used for shoulder and elbow joints to be compliant in horizontal direction for vertical insertion tasks. It is basically used for the assembly purpose.	Explanation of cylindrical robot – **1 M** Sketch - **1M** Explanation of arm assembly robot – **1 M** Sketch - **1M**

			
	f) Ans:	**Write the classification of sensors used in robotics.** Robotic sensor can be classified by number of method. Some of them are listed below: **(a) According to quantity to be measured** • Mechanical sensors • Electronic sensor • Magnetic sensor • Thermal sensor **(b) According to function** • Sensors for manipulation • Sensor for data acquisition **(c) According to type of detection** • Internal state sensors • External state sensors **(d) According to nature of contact** • Contact type sensors • Noncontact type sensors.	Any 4 Points – **4M**
6		**Attempt any TWO of the following**	**(2×8=16)**

	a) **Ans:**	**Enlist the various functions of PPC. Describe:** (i) Scheduling (ii) Routing in details. **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.	Any 8 functions – **4M** Explanation of scheduling **– 2 M** Explanation of routing. **– 2 M**
	b) **Ans:**	A particular activity on the shop floor consists of three elements. Calculate standard time for the activity. Total allowances are given as percentage of normal time. **Elements** | **I** | **II** | **III** Observed time (min.) | 1.20 | 0.50 | 0.80 Rating Factor (%) | 80 | 90 | 75 Total Allowances (%) | 22 | 19 | 20 **a) For Element I:** Basic time for the operation = (Observed time × Rating) / std. rating = (1.20 × 80) /100 = 0.96 min.	Standard time calculation of each element – **2M for each. (2×3 = 6M)**

		Total allowances = 22% of normal time = (0.96 × 22)/100 = 0.2112 min. Standard Time = Basic time + Total allowances. = 0.96 + 0.2112 = 1.1712 min. **b) For Element II:** Basic time for the operation = (Observed time × Rating) / std. rating = (0.50× 90) /100 = 0.45 min. Total allowances = 19% of normal time = (0.45 × 19)/100 = 0.0.0855 min. Standard Time = Basic time + Total allowances. = 0.45 + 0.0855 = 0.5355 min. **c) For Element III:** Basic time for the operation = (Observed time × Rating) / std. rating = (0.80 × 75) /100 = 0.6 min. Total allowances = 20% of normal time = (0.96 × 22)/100 = 0.12 min. Standard Time = Basic time + Total allowances. = 0.6 + 0.12 = 0.72 min. **Standard time for the activity** = Standard time of element (I+II+III) = 1.1712 + 0.5355 + 0.72 = **2.4267 min**……(**Ans.)**	Calculation of std. time of activity – **2M**
	c) Ans:	Describe any two joint types used in robotic arm and wrist. **Joint types used in robotic arm:** **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.	Any two types description with neat sketch – **4 marks each.**

		• 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)	Description – **2 M** Sketch- **2 M**