



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.

Q.1 a) i) What are the various tools of productivity? How productivity can be increased?

Ans.:- Tools of productivity: (Any 4 points - 2 marks)

1. Work study- The technique of method study and work measurement employed to ensure the best possible use of human and material resources in carrying out the specific activity.
2. Motion Study: It is the detail study of manual and/or body motions used in a work task or at one work area, often involving comparative analysis of right and left hand motion.
3. Motion economy: This method use the basic principles of the manner in which body motions are perform to simplify and reduced the work content.
4. Work simplification: With the help of this method, improvement in work methods or work flow, initiate and developed by superiors or the workers on the job as a result of methods training and/or economic incentives.
5. Job Design: The establishment of job content using the concept of enlarging or broadening the scope, variety and responsibility of a job in order to improve personal job satisfaction and increased output quality and quantity.
6. Total Quality Management (TQM): TQM means set of activities involving everybody in an organization in a totally integrated efforts improving performance at every level.

Productivity can increased by following ways: (Any Four points – 2 Marks)

1. By effective utilization of material.
2. By effective utilization of machinery and equipment.
3. By selecting proper layout.
4. By providing good working conditions.
5. By using advanced techniques for manufacturing.
6. By proper selection of material handling equipment.
7. By designing a product with proper tolerance and specification.

ii. List down the different types of production system in industry and give practical example of each type of production system.

Ans.:- Types of Production system. (Each type with example – 1 Mark)

1. Intermittent production
 - a. Job order production system: Examples - Repair shops, fabricators, Special purpose machine manufacturer industries, Civil works etc.
 - b. Batch order production system: Examples - Cloth manufacturer, Furniture manufacturer, Chemical plant, Heavy vehicles manufacturer industries etc.
2. Continuous production
 - a. Mass production system: Examples – Manufacturing industries of metal screws, plastic products, pens, assembly line of automobile, T. V. Sets, Electric fan etc.
 - b. Process production: Examples – Sugar industry, Steel industry, Cement industry, Paper industry etc.

iii) State the benefits of productivity to management and workers.

Ans.:- Benefits to management (any 4 point- 2 Marks.)

- a. Higher productivity earns good reputation of the firm.
- b. Ensures stability of the firm.
- c. Results in more profit.
- d. Result in increased sales and provide opportunity for expansion.

Benefits to workers. (Any 4 points - 2 Marks.)

- a. It gives more wages and incentives.



- b. It provides safe and better working condition.
- c. Job satisfaction and job security.
- d. Standard of living of worker is improved.

iv) Explain the factors affecting process planning.

Ans.:- Factors affecting process planning. (Any 4 points with appropriate explanation-4 Marks)

- a. Size and shape of part: The size and shape of many components decides the basic operations for the manufacturing of part. For example : For manufacturing a shaft, the necessary information is shape of raw material, size of shaft, according to that we select the sequence of operations, machines to be used and material handling activities.
- b. Strength characteristics of the part: The part strength also decide that which type of process is employed for producing it. Because the different types of load acted on the part during its working such as impact load, tensile load or shock load etc. according to that process planning is done.
- c. Quantity required: According to the no. of output produced, the process planning is decided. For example: Part which is manufacture in large no. for that general purpose machine is used and for large size and less no. of part special purpose machines are used.
- d. The accuracy and surface quality required: For achieving accuracy, product should be manufactured such a way that it should give higher dimensional accuracy and high degree of surface finish according to that machines and process is to be selected.
- e. Utilization of existing equipments: While selecting the process, full capacity of existing machines & its tooling must be utilized, otherwise the existing machinery will remain idle and more capital will be invested on new machines.
- f. Skill of manpower: Skill of available manpower must be known to determine the need for added operations to avoid defectives due to poor workmanship.
- g. Delivery date of components or product: Short time period of delivery generally do not allow process engineer to select most economical process and tool for economic production. Due to insufficient time, he may use less efficient machine and tool on hand. On other hand, longer delivery schedule give process engineer sufficient time to go details of each aspect to select most economical process.

Q.1 b) i) Give the consideration for designing the plant layout.

Ans.:- (Any 6 point with appropriate explanation - 6 Marks)

Following are the various considerations for designing plant layout.

1. Overall integration: A good layout is one that integrates men, materials, machine and supporting services, and others in order to get the optimum utilization of resources and maximum effectiveness.
2. Smooth flow of product: A good layout is one that makes the material to move in forward direction towards the completion stage, i.e., there should not be back tracking.
3. Minimum distance travelled: This means minimum movement of men and materials. The facilities should be arranged such that, the total distance travelled by the men and material should be minimum and as far as possible straight line movement should be preferred.
4. Space utilization: The good layout is one that utilized both horizontal and vertical space. It is not only enough if only the floor area is utilized optimally but the third dimension, i.e., the height is also utilized effectively.
5. Flexibility: The good layout is that can be altered without much cost and time, i.e., future requirements should be taken into account while designing the present layout.
6. Minimum handling: A good layout is that which reduced the material handling to minimum.
7. Maximum visibility: The plant should be planned in such a way that, there should not be any difficulty in supervision, co-ordination and control. There should not be no 'hiding space' into which goods can be mislaid.
8. Employee satisfaction and safety: A good layout is one that gives due consideration to workers safety and satisfaction and safeguard the plant and machinery against fire, theft etc.
9. Maximum accessibility: All servicing and maintenance point should be readily accessible without making any hindrance to the production process. For this purpose there must be sufficient space between different machines.

ii) Define scheduling. What are various steps taken to control the production scheduled.

Ans.:- (Definition- 2 Marks, Steps- 4 Marks)

Scheduling: It is the assignment of work to the facility with the specification of time. Scheduling is the time phase of loading specifying starting and end time for a particular work to be done.

Various steps taken to control the production schedule are as follows:

1. Data collection : to collect the data what is actually happening (Progress of work)
2. Data interpretation: Compare the collected data with the planned schedule.
3. Expediting: if there is any deviation found from the planned scheduled, a corrective action should be taken. This known as expediting.
4. Re-planning: In expediting, if it is found that it is impossible to perform according to plan, then it is necessary to re-plan the whole activities.



Q.2 a) Explain the different types of automated guided vehicle (AGV) system and also state its function and application.

Ans.:- Types of AGV (4 Types with appropriate explanation- 4Marks)

1. Wire guided AGVs: These AGVs follow as inductive wire as guided path.
2. AGVs having optical/chemical/magnetic guide path: These AGVs use a strip of optical/chemical/magnetic material on their guide path.
3. Dead reckoning AGVs: These AGVs are based on the principle of odometry. These use memory in their on board microcomputer for their movement.
4. Free ranging AGVs: Unlike wired AGVs the free ranging AGVs does not follow any physical guided path. Path of these AGVs is not fixed but can be altered by using software program. The guidance of such AGVs is based on following techniques:
 - a. Position reference beacons and
 - b. Optical imaging of surrounding and stereoscopic vision.

Functions: (Any 2 Points- 2 Marks.)

1. To carry load from one location to other in an automated work place, in predetermined path.
2. To select its own route/path to reach the destination without the human intervention for guidance or control.
3. It may facilities the effective implementation of MIS (manufacturing information system.)
4. AGV system can be easily interfaced with other modules of flexible manufacturing system such as robot, automatic storage and retrieval system etc.

Applications: (Any 2 applications- 2 marks.)

1. Assembly line operation.
2. Used in Flexible Manufacturing system and Computer integrated manufacturing system.
3. Non industrial applications like hospitals, offices etc.

b) Prepare operation process sheet and sequence of operation for the Ring nut shown in figure. Assume suitable cutting parameter and raw material $\phi 50 \times 10$ mm blank of carbon steel.

Ans.:- Logical Description of operations---4M

Format of Operation sheet ----2M

Logical selection of material, Tools, Machines etc –2M

Note: - Weightage should be given to the logic developed by candidate .Description of operation, machines may change.

Part Name: Ring Nut		Material: Carbon steel				
Part no:		Material Size: $\Phi 50 \times 10$ mm, blank				
Opn no	Description of operation	Machine used	Tools /Fixtures used	Feed mm/rev	Cutting speed m/min	Depth of cut mm
01	Clamp the blank in chuck and face one side	Centre lathe no...	H.S.S.,R.H. Turning tool	0.0025	30	-
02	Reverse the blank in the chuck and face other side (Made Width =7.5)	-----"-----	-----"-----	0.025	30	—
03	Drill hole , $\Phi 27$ by fitting drill in tail stock spindle	-----"-----	Drill $\Phi 27$	Medium	30	—
04	Internal threading M 30 \times 1.5	-----"-----	Boring bar		6	—
05	Turn $\Phi 45$	-----"-----	Mandrel	0.025	30	1.0
06	Chamfer 0.5 \times 45 ⁰	-----"-----	R.H.Tool	0.025	30	—
---07	Reverse the job and chamfer 3.5 \times 30 ⁰	-----"-----	-----"-----	0.025	30	—
08	Mill slot (4 no.) 5 \times 2 Deep	Horizontal Milling machine No.....	Mandrel ,side Milling Cutter of 5 mm width	07/ Tooth	25	3



09	Grinding one side	Cylindrical Grinding Machine No	Indexing head	–	100	0.05
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c) Explain the various steps for planning a process for product from raw material to finished product in an industry.

Ans.:- Minimum 8 steps – 01 Mark each

1. Analysis of Product and its specification: - During analysis, following parameter should be considered-
 - a. Drawing and specification of product.
 - b. Quality of product.
 - c. Number of parts/components per product.
2. Make or buy decision: Process planning determines what parts are to be manufactured in the firm itself and what parts are to be purchased from outside.
3. Selection of basic manufacturing process: Once the decision is taken what parts to be manufactured, next step is to decide the manufacturing process. The alternative methods are compared and most practical and economical method is decided by calculating and comparing total cost for two or more feasible method.
4. Determining sequence of operation: Once the best manufacturing process is selected, sequence of operation to be performed on each component is determined.
5. Combine the operations: If possible practically, combine as many operations as possible. As it is economical to combine the operations.
6. Selection of machine tools/equipments: Selection of correct machine is closely related to the process of manufacture. While selecting the machine, following factors should be considered:
 - a. Size and form of work piece.
 - b. Accuracy and surface finish required.
 - c. Quantity required.
7. Inspection: At this stage, inspection devices and stages are decided.
8. Requirement of tools, gauges etc.: To determine and order the tools and gauges required to manufacture the part.
9. Labour requirement: Kind/Skill of labour required to do the job.
10. Time standards: To determine the time standards for performance of the job and fixing the rates of payment.
11. Prepare the route sheet and operation sheet.

Q.3

a) What is the salient feature of industrial policy as regards to backward areas?

Ans.: Salient features of industrial policy: (Any 4 points - 4 Marks)

1. Industrial extension services through small industries service institute and other organizations.
2. Factory space in industrial estate through cooperative and other industrial estates, ready built shades and developed industrial plots made available through state government agencies.
3. For attracting industrialist and entrepreneurs for starting plants in backward areas government is offering various financial and tax concession.
4. Government of India has setup "National Equity fund" to provide assistance to small enterprises in rural areas.
5. Attempt is made for easily availability of license and approval of small scale industries in rural areas.
6. Provision of training facilities.
7. Subsidized power tariffs and exemption of electricity duties.
8. Preference for products produced in small-scale industries and 15% price performance to them in state government purchases.
9. Reservation of product for exclusive manufacture in the small-scale sector.

b) Explain the need and importance of material handling devices in an industry.

Ans.: Need of material handling devices: (2 Marks for appropriate explanation.)

Material handling is an important activity in the industries. A large part of indirect labour employed in an industry is engaged in handling of materials. It has been estimated that average material handling cost is roughly 20 to 30% of total production cost. A component may be handled 50 times or more before it changes to finished product. It thus becomes clear that the cost of production of an item can be reduced considerably by making a savings in the material handling cost. The selection of proper material handling equipment reduces cycle time of product and also the chances of accidents.

Importance of material handling devices: (Any 4 points - 2 Marks)

1. Minimize cost of material handling.



2. It increases production capacity of the plant by effective utilization of materials.
3. It minimizes delays and interruption by providing material at the point of use at right time and right quantity.
4. It prevent damaged to material.
5. It provides safety in material handling and provides proper working conditions.
6. Reduced in process inventory.

c) State the various stages at which inspection should be planned.

Ans.: Stages of inspection: (Any 4 points - 4 Marks)

1. Inspection of incoming materials, raw materials or received materials including bought out items.
2. In process inspection: It includes following stages;
 - a. Inspection should be conducted before long production run.
 - b. Inspection should be conducted on first few parts of the new machine or new operation.
 - c. Inspection should be conducted before an operation where no rework is possible.
 - d. Inspection is carried where part goes for an expensive operation.
 - e. Inspection should be conducted where series of operations are completed on part.
 - f. Inspection may be conducted where parts are being sent to the plating or painting.
 - g. Inspection should be conducted on parts before they move to the next department.
 - h. Inspection should be conducted on completed assemblies under conditions similar to field conditions.
3. Inspection of finished goods.

d) Explain the following terms in context with work study.

- i. Therbligs.
- ii. MTM (Method Time Measurement)

Therbligs : (Explanation: 1 Mark, Any one example : 1 Mark)

1. Therbligs are used to describe the basic element of movement or fundamental hand motions of the work cycle.
2. Every therbligs is presented by a symbol, a definite colour and name. (Letter or word)
3. Therbligs refers primarily to motions of human body at workplace and to mental activities associated with them.
4. For example:

Sr.no.	Therbligs	Symbol		Colour	Application
1	Assemble	#	A	Violet	Putting object together.
2	Select	→	ST	Light gray	Choosing one object from amongst many.
3	Grasp	∩	G	Red	Taking hold of something.
4	Use	U	U	Purple	Manipulating or causing a tool to do its function.

MTM -Method Time Measurement: (Appropriate Explanation – 2 Marks)

1. It is a procedure which analyses any manual operation or method into the basic motions required to perform it and assigns to each motion a predetermined time value by the nature of motion and the conditions under which it is made.
2. M.T.M. was developed from motion picture studies on industrial operations and time standards, the time unit is known as T.M.U. one TMU = 0.0015 minute.
3. Basically M.T.M. is a tool of method analysis that provides the answers in terms of time without the use of stop watch.
4. There are different motions such as Reach, Move, Turn, Grasp, etc. Each motion is given a number such as case A for reach, which is to reach for object in a fixed location. A table of distance is given with values, which vary according to whether the hand is in motion or not and so on. Such tables are prepared on the basis of research.
5. For a particular job when all motions have been identified, classified and recorded, the time value for each is determined from the MTM data. The sum of these motion times is the time an operator of average skill would take to perform the task.

e) List down various types of clamping devices used in design of Jigs. Explain any one with sketch.

Ans.:- List of Types of clamping devices used in design of jigs. (Any four- 2 Marks)

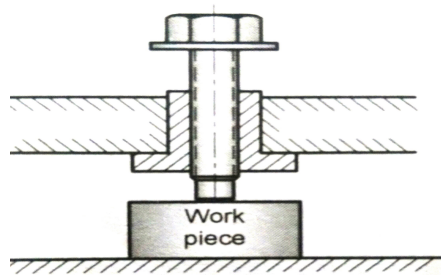
- i. Screw clamp

- ii. Pivoted clamp.
- iii. Equalizing clamp.
- iv. Latch clamp.
- v. Wedge clamp.
- vi. Hinged jaw clamp.
- vii. Lever operated clamp.
- viii. Two way clamp.
- ix. Cam operated clamp.

(Explanation of any one type with neat sketch: 2 Marks, 1 mark for explanation and 1 mark for sketch.)

For example:

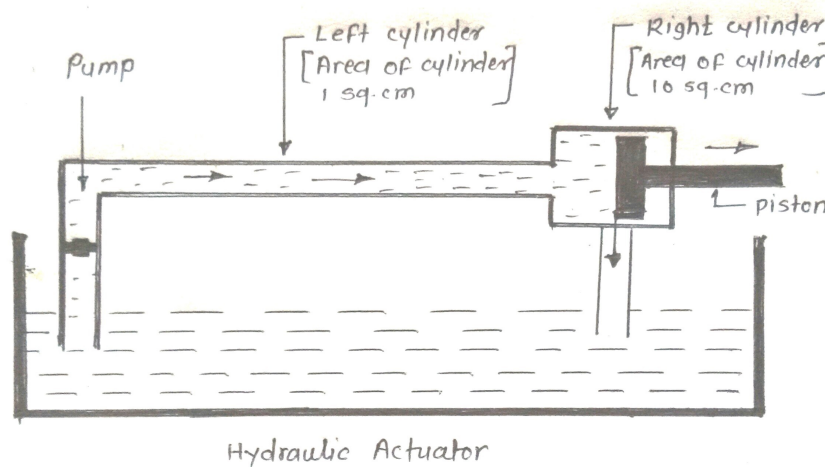
Screw clamp: Screw clamps are particularly useful when a component is to be gripped on its edges as shown in figure. This arrangement ensures easy machining of the work piece



f) Explain the principle of working of hydraulic actuator and state its advantages.

Ans.: Working Principle of Hydraulic Actuator (2 Marks)

1. According to Pascal, when there is an increase in pressure at any point in a confined incompressible fluid, then there is an equal increase at every point in the container. Hydraulic actuators are designed based on this principle (Pascal's law).
2. To understand how hydraulic actuators works, let's take an example of two cylinders connected together as shown in the figure. Suppose one cylinder has cross sectional area of 1 sq.cm. and the second one has cross section area of 10 sq.cm. If the cylinders are filled with incompressible fluid and 1 unit of pressure is applied to the left cylinder pushing the pump (actually liquid) by 10 cm. Then the resulting force acts on the right cylinder pushing the piston by 1 cm, but with a force of 10 units. This means applying 1 unit of force produces 10 units of force on the other side.



3. Similarly, hydraulic actuators are majorly used for a systems which require very large force, but not very restrictive on positioning and accuracy.

Advantages of hydraulic actuators: (Any 2 – 2 Marks)

1. They can move moderate to heavy loads.
2. They are more efficient and deliver better performance than others.
3. Power to weight ratio of these actuators is high.

Q. No.	Sub. Q. No.	Answer Key/Particulars	Stepwise Mark Distribution
4	A	Attempt Any THREE of the following:	(3 x 4)
4(a)	(i)	What are the different types of Fixtures? Explain any one with sketch.	
		<p>Types of Fixtures:</p> <p>Following are the types of Fixtures according to the type of machine operations for which they are used.</p> <p>[1] Lathe (Turning) Fixture [2] Milling fixtures</p>	1 Mark for enlisting the types of

- [3] Grinding fixture
- [4] Assembling fixture
- [5] Welding Fixture
- [6] Fixture for broaching

fixtures
(Any 4 valid types)

[1 Mark for enlisting the types of fixtures (Any 4 valid types)]

Description of different types of fixtures:

1. Lathe (Turning) Fixture:

- [1] The standard work holding devices or fixtures for a lathe are, 3 and 4 jaw chucks collets, face plate, mandrels etc.
- [2] **Three Jaw Chucks** are used to hold round or hexagonal bar stock or other symmetrical work.
- [3] **Four Jaw Chucks** are used for rough castings and square or octagonal work.
- [4] **Collets** are used primarily for bar stock.
- [5] **Face plates** can be mounted and supported to some types of jobs like pipe elbow.
- [6] **Mandrels** supported and held hollow jobs such as gear blanks and pulleys.
- [7] **Milling Vice** can be mounted on lathe bed in place of compound rest, to hold the work and the cutter is inserted in the lathe spindle.

2 Mark for Brief Description any one of Fixture,

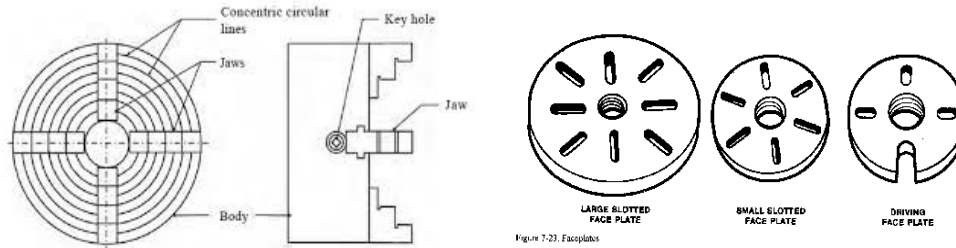


Figure: Four Jaw Chuck and Face Plates

1 Mark for neat sketch

2. Milling Fixture:

- [1] A milling fixture is a work holding device, firmly clamped or attached to the table of the milling machine.
- [2] It holds the work piece in correct position as the table movement carries it past the cutter.
- [3] It performs different types of milling operations.
- [4] The Milling fixture base can be secured to the table by means of T-bolts and nuts.

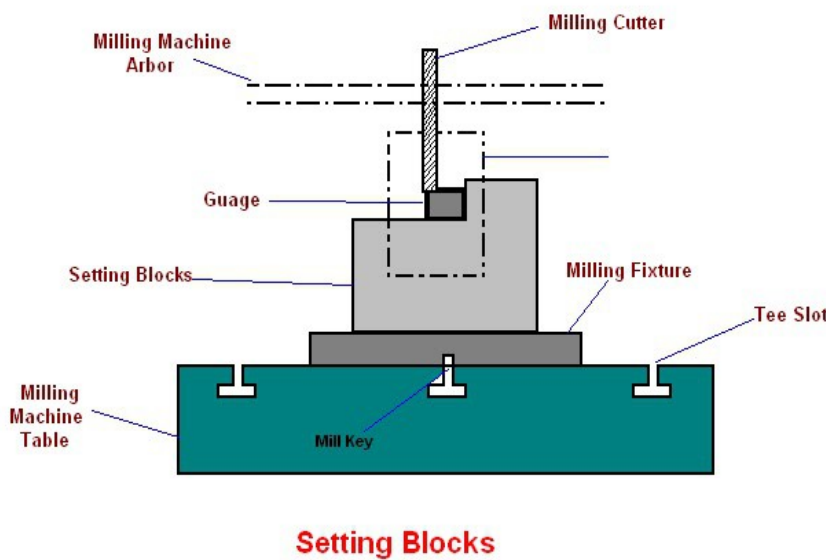


Figure: Application of Milling Fixture

3. Grinding Fixture:

The work holding devices for grinding operations will depend upon the type of grinding operation and the machine used.

Mandrel: The mandrel is used for internal chucking of round work piece with bores. The work piece is located and held on the mandrel with the help of the bore so that the external surface may be machined truly concentric to the bore. Taper, straight and combined taper and straight mandrels are used as fixture for external grinding.

Chucks: For grinding internal surfaces of simple circular work pieces, the chuck may be used as standard work holding devices. Vacuum and magnetic types of chucks are used for this purpose.

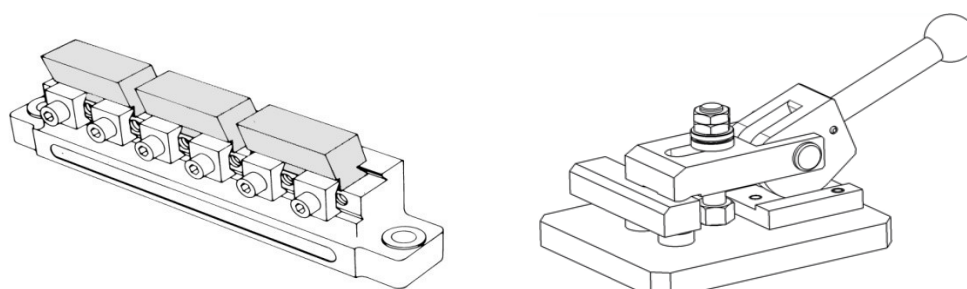




		Figure: Application of Grinding and Assembly Fixture																									
		<p>4. Assembling Fixture:</p> <p>They are used to hold the various components in their correct position while they are assembled. This is particularly the case when the various parts are to be put together for welding. They are simple and effective means used to mechanize the manual assembly operations. Universal and special purpose fixtures are falls in this category.</p> <p>5. Welding Fixture:</p> <p>[1] Welding fixtures are normally designed to hold and support the various components (work pieces) to be welded. [2] It is necessary to support them in a proper location which is capable of preventing distortions in work pieces during welding. [3] For this the locating elements need to be placed carefully, clamping has to be light but firm, placement of clamping elements has to be clear of the welding area.</p> <p>6. Broaching Fixture:</p> <p>Broaching fixture is used for internal broaching operations. In the simple broaching fixture, a round hole, supporting flange is located and secured with T bolts to face plate of the machine.</p> <p>Broaching fixtures hold the job rigidly, locate the job in correct position relative to the tool of the machine table and guide the broaching tool in relation to the job.</p> <p>(2 Mark for Brief Description of any one Fixture, 1 Mark for neat sketch)</p>																									
4(a)	(ii)	Explain the importance of ‘5S’ (“Five S”) Concept.																									
		<p>Introduction of 5 S Concept:</p> <p>[1] 5S is a process of workplace organization and housekeeping which is carried out gradually and systematically. [2] It is a structured program to implement workplace organization and standardization. [3] A well organised workplace motivates people, both on the shop floor as well as others. [4] 5S improves safety, work efficiency and productivity. [5] Five S is an integrated Japanese concept for proper housekeeping and they call it as “Workplace Management”. [6] According to Japanese, effective work place management calls for five steps also known as pillars of 5S, Viz.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>S.N.</th> <th>Parameter</th> <th>Japanese Term</th> <th>Meaning</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>1st S</td> <td>SEIRI</td> <td>Organizing (Sorting)</td> </tr> <tr> <td>2</td> <td>2nd S</td> <td>SEITON</td> <td>Neatness (Simplify)</td> </tr> <tr> <td>3</td> <td>3rd S</td> <td>SEISO</td> <td>Cleaning (Sweep)</td> </tr> <tr> <td>4</td> <td>4th S</td> <td>SEIKETSU</td> <td>Standardization</td> </tr> <tr> <td>5</td> <td>5th S</td> <td>SHITSUKE</td> <td>Self Discipline (Sustain)</td> </tr> </tbody> </table> <p>Importance of ‘5S’ (“Five S”) Concept:</p> <p>[1] It is the silent informer of a Company’s attitude to quality. [2] It is symbol of Team work. [3] It is useful for Marketing a Product. [4] It improves the quality of human behavior.</p> <p>In fact, 5S is a basic step in a journey towards Total Quality Management (TQM).</p> <p>(2 Marks for Significance of 5S, 2 Marks for Importance of 5S)</p>	S.N.	Parameter	Japanese Term	Meaning	1	1 st S	SEIRI	Organizing (Sorting)	2	2 nd S	SEITON	Neatness (Simplify)	3	3 rd S	SEISO	Cleaning (Sweep)	4	4 th S	SEIKETSU	Standardization	5	5 th S	SHITSUKE	Self Discipline (Sustain)	<p>2 Marks for Significance of 5S</p> <p>2 Marks for Importance of 5S</p>
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4(a)	(iii)	Explain the concept of JIT and how does it help the manufacturing system to improve productivity?																									
		<p>Concept of JIT:</p> <p>[1] JIT is a Production methodology which aims to improve overall productivity through elimination of waste and which leads to improved quality. [2] JIT concept was implemented in Japan to eliminate waste of materials, machines, capital, manpower and inventory throughout the manufacturing system. [3] JIT is a philosophy rather than a technique. By eliminating all wastes and seeking continuous improvement, it aims at creating a manufacturing system that is responsive to the market needs.</p>	<p>2 Marks for Concept of JIT in brief</p>																								



		<p>[4] It was first developed and perfected within the Toyota Manufacturing Plants by Taichi Ohno as a means of meeting customer demands with minimum delays. For this reason Taichi Ohno is known as the father of JIT.</p> <p>(2 Marks for Concept of JIT in brief)</p> <p>Importance of JIT for Improving Productivity of Manufacturing System:</p> <p>[1] JIT receives supplies just in time to be used.</p> <p>[2] JIT produces parts just in time to be made into subassemblies.</p> <p>[3] JIT produces subassemblies just in time to be assembled into finished products.</p> <p>[4] JIT produces and delivers finished products just in time to be sold.</p> <p>[5] JIT is a well integrated system resulted in increase in quality, productivity with zero defects.</p> <p>[6] JIT reducing the level of wasted materials, time and effort involved in production processes.</p> <p>[7] JIT identifying and responding to consumer needs.</p> <p>[8] Its ease of manufacturing</p> <p>[9] Its reduces inventory</p> <p>[10] Its reduces inspection</p> <p>[11] It improves quality continuously.</p> <p>[12] It provides Higher flexibility to production system.</p> <p>[13] It improves customer satisfaction</p> <p>[14] It improves working condition and relation between employees.</p> <p>(2 Marks for Importance of JIT for Improving Productivity, Enlist any 8 Points from the above mentioned)</p>	<p>2 Marks for Importance of JIT for Improving Productivity,</p> <p>Enlist any 8 Points from the above mentioned</p>
4(a)	(iv)	Give classification of robot sensor.	
		<p>Classification of Robot Sensor:</p> <p>Robot Sensors senses and capability includes vision and hand eye coordination, touch, hearing, sensors will divided into the following categories.</p> <p>[1] Vision Sensor:</p> <p>Robot vision is made possible by means of video camera, a sufficient light source and a computer programmed to process image data. The camera is mounted either on the robot or in a fixed position above the robot so that its field of vision includes the robots work volume.</p> <p>[2] Tactile Sensor:</p> <p>Tactile sensors provide the robot with the capability to respond to contact forces between itself and other objects within its work volume. Tactile sensors can be divided into two types:</p> <p>2.1 Touch Sensor is used simply to indicate whether contact has been made with an object. A simple micro switch can serve the purpose of a touch sensor.</p> <p>2.2 Stress Sensor is used to measure the magnitude of the contact force. Strain gauge devices are typically employed in force measuring sensors.</p> <p>[3] Proximity Sensor:</p> <p>They are used to sense when one object is close to another object. On a robot, the proximity sensors would be located on or near the end effectors.</p> <p>[4] Voice Sensor:</p> <p>Voice programming can be defined as the oral communication of commands to the robot or other machine. The robot controller is equipped with a speech recognition system which analyzes the voice input and compares it with a set of stored word patterns. When a match is found between the input and the stored vocabulary word the robot performs some actions which correspond to the word.</p> <p>(4 Marks for Detail Classification of Sensor with brief description)</p>	<p>4 Marks for Detail Classification of Sensor</p> <p>with brief description</p>
4	b	Attempt Any ONE of the following:	(1 x 6)
4(b)	(i)	If a worker takes 15 minutes as a standard time for a job in which total allowance is 20 % of normal time. If the rating of worker is 100 % find actual time required by the worker.	



	<p>Given Data:</p> <p>Standard Time (ST) = 15 Minutes</p> <p>Rating Factor (RF) = 100 %</p> <p>Allowance = 20 % of Normal Time (NT)</p> <p>Standard Time (ST) = Normal Time (NT) + Allowance</p> $15 = NT + (20/100) NT$ $15 = NT + (1 + 0.2)$ $NT = 15/1.2$ $NT = 12.5 \text{ Minutes} = \text{Basic Time (BT)}$ <p>We Know That,</p> $\text{Basic Time} = (\text{Observed (Actual) Time} \times \text{Rating Factor}) / 100$ $12.5 = (\text{Observed (Actual) Time} \times 100) / 100$ $12.5 = \text{Observed (Actual) Time}$ <p>Actual (Observed) Time (AT) required by the worker to complete the job is 12.5 Minutes.</p> <p>(2 Marks for writing Given Data, 2 Marks for Calculation of NT (BT), 2 Marks for Calculation of Actual Time)</p>	<p>2 Marks for writing Given Data,</p> <p>2 Marks for Calculation of NT (BT),</p> <p>2 Marks for Calculation of Actual Time)</p>
4(b)	(ii) Explain with suitable sketch 3-2-1 principle of location used in jigs and fixtures.	
	<p>3-2-1 Principle of Location used in Jig & Fixtures:</p> <p>[1] It is also known as six pin or six point location principle. In this, the three adjacent locating surfaces of the blank (work piece) are resting against 3, 2 and 1 pins respectively, which prevent 9 degrees of freedom.</p> <p>[2] The rest three degrees of freedom are arrested by three external forces usually provided directly by clamping.</p> <p>The 3-2-1 principle states that the six locators are sufficient to restrict the required degree of freedom of any work piece. In this, motion is restricted using clamps and locators. A three pin base can restrict five motions and six pins restrict nine motions.</p> <p>(1 Mark for Statement of 3-2-1 Principle with proper Introduction)</p> <p>Methodology of 3-2-1 Principle: For this, refer the below figure;</p> <p>[1] The work piece is resting on three pins A, B and C which are inserted in the base of the fixed body.</p> <p>[2] The work piece cannot rotate about the axes XX and YY and also cannot move downward.</p> <p>[3] In this way, the five degrees of freedom 1,2,3,4 and 5 have been arrested.</p> <p>[4] Two pins D and E are inserted in the fixed body, in a plane perpendicular to the plane containing pins A, B & C.</p> <p>[5] Now the work piece cannot rotate about the Z axis and also it cannot move towards the left.</p> <p>[6] Hence the addition of pins D and E restrict three more degrees of freedom, namely 6, 7 and 8.</p> <p>[7] Another pin F in the second vertical face of the fixed body, arrests degree of freedom 9.</p> <p>The above method of locating a work piece in a fixture is called the 3-2-1 Principle.</p> <p>(3 Marks for Methodology with proper explanation of 3-2-1 principle)</p>	<p>1 Mark for Statement of 3-2-1 Principle</p> <p>with proper Introduction</p> <p>3 Marks for Methodology with proper explanation of 3-2-1 principle</p>

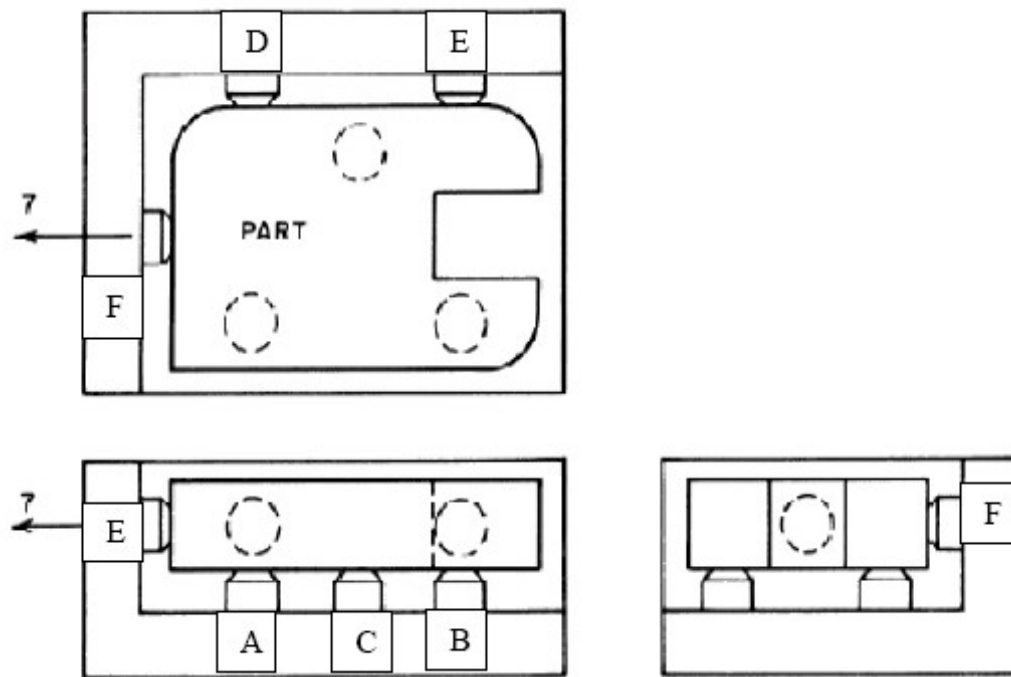


Figure: Example of 3-2-1 Principle with work piece located in a fixed body

(2 Marks for neat labeled sketch of 3-2-1 Principle)

Summary of 3-2-1 Principle:

A work piece will be completely confined when blanked against:

3 points in one plane: The “3” in 3-2-1 refers to 3 locators (passive fixture elements) on the primary locating/datum surface.

2 points in another plane: The “2” in 3-2-1 refers to 2 locators on the secondary locating/datum surface.

1 point in a third plane: The “1” in 3-2-1 refers to 1 locator on the tertiary locating/datum surface

2 Marks for neat labeled sketch of 3-2-1 Principle

5 Attempt Any **FOUR** of the following:

(4 x 4)

5 (a) State the functions of production planning.

Function of Production Planning:

Production planning is the determination, acquisition and arrangement of all facilities necessary for future production of products. It performs following functions;

- [1] To operate the plant at a predetermined level of efficiency.
- [2] To obtain a prescribed level of profit.
- [3] To reduce the manufacturing costs through R & D.
- [4] To efficiently utilize the available resources and plant facilities.

(4 Marks for Function, 1 Mark for each point)

1 Mark for each point

5 (b) What is ejector? Explain role and necessity of ejector in the design of jigs and fixtures.

Ejector:

Ejector is used to remove the work piece from close fitted locators and is present behind the work piece. Ejector speed up the operation by reducing unloading time. This increases the production rate.

(2 Marks for Significance of Ejector)

Role & Necessity of Ejector in the Design of Jigs & Fixtures:

- [1] The ejector is not convenience but an economic asset which reduces the time of removal of the part.
- [2] The time saving may appear small, however for large volume production with short duration operation cycle.
- [3] By eliminating the need for finger and hand space for gripping the part the ejector permits a reduction of the overall dimensions thus the cost of the fixture.
- [4] Ejector eliminates inconvenient and awkward hand manipulation and reduces operator fatigue.
- [5] For maximum time saving, the operation of the ejector can be automatic and coupled with the release of clamp. [6] The combined mechanism used in Ejectors can be powered hydraulically or by compressed air.

(2 Marks for Role & Necessity of Ejector)

2 Marks for Significance of Ejector

2 Marks for Role & Necessity of Ejector



5	(c)	State advantages and disadvantages of ERP System.	
		<p>Advantages of ERP System:</p> <p>[1] Improved efficiency across business due to timely availability of information. [2] Better decision making owing to information integration. [3] Reduced inventory costs due to better inventory management. [4] Faster response to customer queries. [5] Reduced operational costs. [6] Improved customer satisfaction. [7] Improved customer goodwill. [8] Improvement in overall corporate image. [9] Improvement in utilization of organizational resources. [10] Improvement in information accuracy. [11] Improvement in decision making.</p> <p>Disadvantages of ERP System:</p> <p>[1] Limited budget. [2] IT infrastructure requirements are not assessed properly. [3] Requires Technology professionals, with right skills. [4] Requires adequate teams from the management side. [5] Core teams involvement and participation in the project is inadequate. [6] The management insists on changes only to the software rather than changes to the traditional processes. [7] Communication to the various stakeholders is inadequate during the project implementation. [8] Lack of project management skills from the client as well as from the consultant's side. [9] Lack of support from the ERP vendor, consultancy firm or the hardware vendor.</p> <p>(2 Marks for Advantages, 2 Marks for Disadvantages, Enlist any 4 Advantages and Disadvantages from the above mentioned list)</p>	<p>2 Marks for Advantages, 2 Marks for Disadvantages Enlist any 4 Advantages and Disadvantages from the above mentioned list</p>
5	(d)	Explain pull type manufacturing system.	
		<p>[1] Pull Type Manufacturing System:</p> <p>[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.</p> <p>Characteristics of Pull (Make to Order) Manufacturing System:</p> <p>[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</p> <p>Examples: Custom Tailored Clothing, Special Purpose Machinery and product made to customer specifications.</p> <p>(2 Marks for Significance, 2 Marks for characteristics with proper examples)</p>	<p>2 Marks for Significance, 2 Marks for characteristics with proper examples</p>
5	(e)	Explain degree of freedom in Robots.	
		<p>Significance of Degree of Freedom (DOF) in Robots:</p> <p>[1] It is a term used to describe a robot's freedom of motion in three dimensional space-specifically, the ability to</p>	

move (i) Forward and backward, (ii) Up and down, and (iii) Left and Right.

[2] For each degree of freedom, a joint is required.

[3] A robot requires six degrees of freedom to be completely versatile.

Concept of DOF in Robots:

The number of degrees of freedom defines the robot's configuration. For example, many simple applications require movement along three axes: X, Y, and Z. Figure shows basic DOF associated with X, Y and Z Axes.

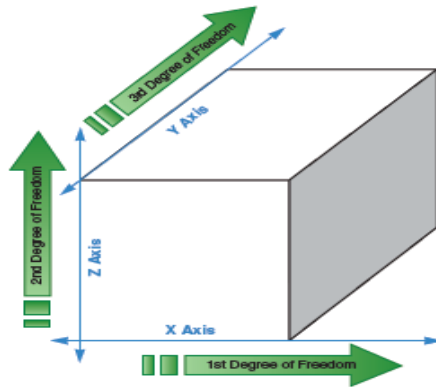


Figure: 3 Basic DOF associate with movement along X, Y, Z axes of Cartesian coordinate system

These tasks require three joints, or three degrees of freedom. The three degrees of freedom in the robot arm are;

[1] **Rotational Traverse:** The rotational traverse is movement on a vertical axis. This is the side-to-side swivel of the robot's arm on its base.

[2] **Radial Traverse:** The radial traverse is the extension and retraction of the arm, creating in-and-out motion relative to the base.

[3] **Vertical Traverse:** The vertical traverse provides up-and-down motion.

For applications that require more freedom, additional degrees can be obtained from the wrist, which gives the end effector its flexibility. The three degrees of freedom in the wrist have aeronautical names Pitch, Yaw and Roll or Swivel as shown in figure:

[4] **Pitch:** The pitch, or bend, is the up-and-down movement of the wrist.

[5] **Yaw:** The yaw is the side-to-side movement of the wrist.

[6] **Roll:** The roll, or swivel, involves rotation (rotary) movement of wrist.

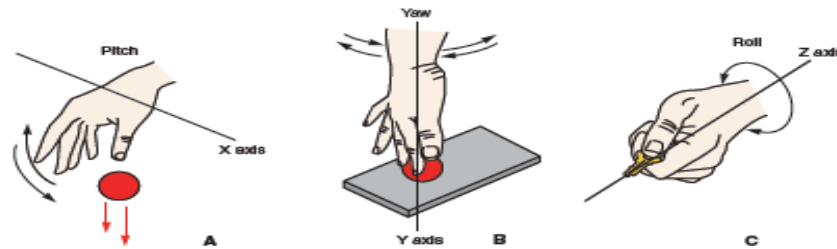


Figure:3 Additional DOF (A. Pitch, B. Yaw, C. Roll) associate with Robots Wrist

(2 Marks for Significance of DOF, 2 Marks for explanation of concept of DOF with simple sketch

2 Marks for Significance of DOF,

2 Marks for explanation of concept of DOF

with simple sketch

5 (f) Explain the basic components of Robots.

Basic Components of Robots:

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

S.N	Elements	Description
1	Mechanical Components	Provides physical robot motion and perform the various tasks. It consists; (1) A Manipulator (Base and Arm Assembly) (2) End of arm tooling (Gripper and End effector) (3) Actuators (Motor or drives) (4) Transmission Elements (Belts, Pulleys, Screw & Gearing)
		It is used to generate necessary signals coordinate the movements of the robot. It includes;

2 Marks for enlisting the Components,



		2	Control System	(1) Mechanical, Electrical, Pneumatic, Hydraulic Controls (2) Sensors (Cameras, Amplifiers & related hardware) (3) Equipment interface	2 Marks for brief explanation
		3	Computer System	It provides the data processing capability necessary to interpolate the intermediate positions and control the movement of the links or arms of the robot. It includes; (1) Microprocessor (PLC or PC's) (2) User interfaces (Keyboard, Display, Teach Pendant) (3) Control software to manipulate robot for various applications	
(2 Marks for enlisting the Components, 2 Marks for brief explanation)					
6		Attempt Any TWO of the following:			(2 x 8)
6	(a)	Explain the GANTT CHART used in production planning and control. State the advantages and disadvantages.			
		<p>Gantt chart used in Production Planning & Control:</p> <p>[1] Gantt chart is a basic tool used for both loading and scheduling. [2] Gantt chart is developed by the Henry Gantt, an American Engineer. [3] Gantt chart is consists of simple rectangular grid, divided by series of parallel horizontal and vertical lines. [4] Vertical lines divided the chart in to units of time. The scale units can be years, moths, weeks, days or hours according to duty for which chart is required. [5] The horizontal lines divided the chart into sections, which can be used to represent either work tasks or work centers.</p> <p>Advantages of Gantt chart:</p> <p>[1] Gantt Chart is simple graphical display technique, suitable for less complex situations [2] Gantt charts are extremely easy to understand. [3] It can quickly reveal the current or planned situation to all concerned. [4] It does not provide any rules for choosing but simply presents a graphical technique for displaying results (and schedule) and for evaluating results (make span, idle time, waiting time, machine utilization, etc.) [5] There is clarity in communicating important shop information by using Gantt chart.</p> <p>Disadvantages of Gantt chart:</p> <p>[1] The Gantt chart must be updated periodically to account for new jobs. [2] It is used for communicate relatively less information. [3] Lack of adequate depiction of interrelationship between the separate tasks. (It means how the ability to start one task depends upon the successful completion of other tasks.)</p> <p>(2 Marks for Significance of GANTT Chart in brief, 3 Marks for Advantages, 3 Marks for Disadvantages)</p>			2 Marks for Significance of GANTT Chart in brief, 3 Marks for Advantages, 3 Marks for Disadvantages
6	(b)	Explain in brief the allowances to be considered while estimating the standard time.			
		<p>Allowances to be considered while estimating the Standard Time:</p> <p>Allowances are added to the normal time in order to arrive at standard time. It is impossible to work throughout the day even though the most practicable, effective method has been developed. Some allowances must therefore be made for recovery from fatigue and for relaxation. Allowances must also be made to enable the worker to attend to his personal needs. There are following types of allowances;</p> <p>[1] Relaxation Allowance:</p> <p>These are calculated so as to allow the worker to recover from fatigue. These are used to provide the worker with the opportunity to recover from physiological & psychological effects of carrying out specified work under specified conditions. The amount of allowance will depend on nature of job.</p> <p>[2] Personal (Need) Allowance:</p> <p>It is intended to compensate the operator for the time necessary to leave, the workplace to attend to personal needs like drinking water, smoking, washing hands. Women require longer personal allowance than men. A fair personal allowance is 5 % for men and 7% for women.</p>			2 Marks for enlisting different type of Allowance,

[3] Fatigue Allowance:

It is an allowance given to compensate for energy expended during working. A common fatigue considered as allowance is 4 % of the basic time

[4] Variable Allowance:

It is allowed to an operator who is working under poor environmental conditions that cannot be improved, added stress and strain in performing the job. The variable fatigue allowance is added to the fixed allowance to an operator who is engaged on medium and heavy work and working under abnormal conditions.

[5] Interference Allowance:

It is an allowance of time included into the work content of the job to compensate the operator for the unavoidable loss of production due to simultaneous stoppage of machines. This allowance is applicable for machine or process controlled jobs.

[6] Contingency Allowance:

It is an allowance of time which may be included in standard time to meet legitimate and expected items of work or delays etc. This allowance provides for small unavoidable delays as well as for occasional minor, extra work. E.g. Tool breakage, Power failures etc.

[7] Policy Allowance:

Basic purpose of this allowance is to line up standard times with requirements of wage arrangement between employers and trade unions. It is an increment, other than bonus increment, applied to standard time to provide satisfactory level of earnings for a specified level of performance under exceptional circumstances. It is used with utmost care and only in clearly defined circumstances.

(2 Marks for enlisting different type of Allowance, 6 Marks for brief explanation of any 4 Allowances mentioned above, 1.5 M of each allowance)

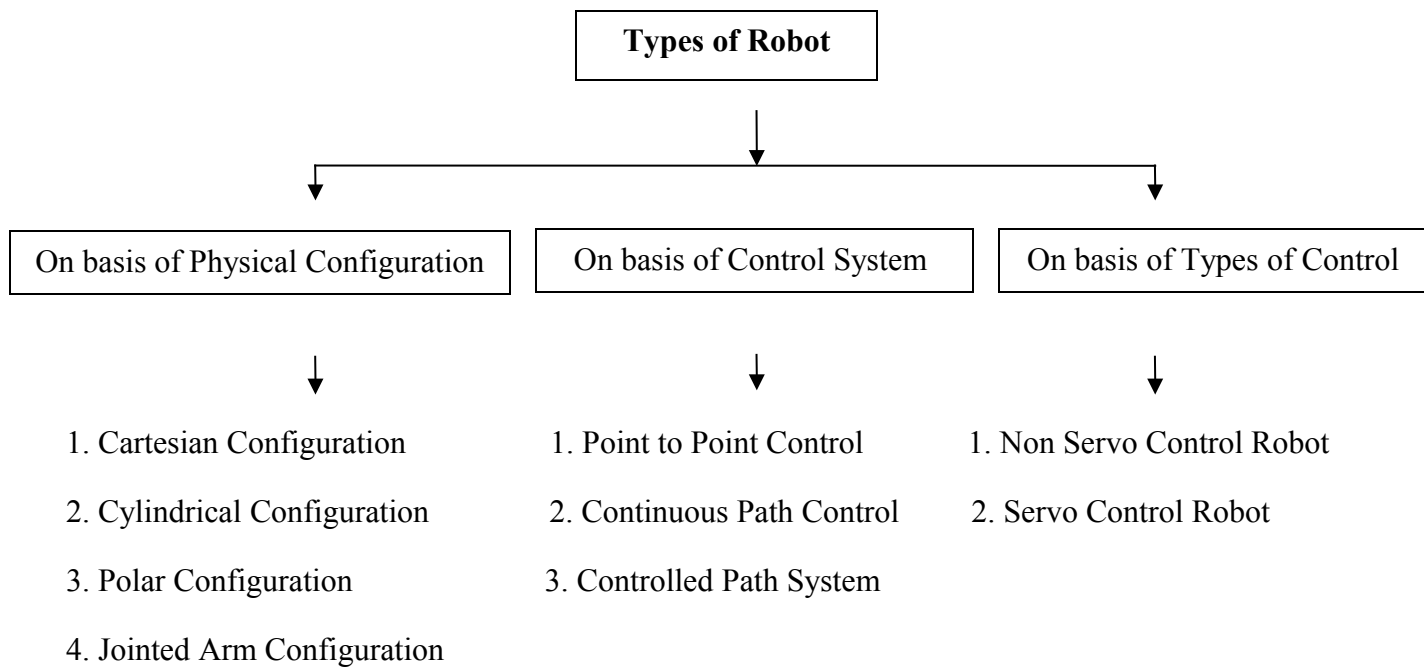
6 Marks for brief explanation of any 4 Allowances mentioned above,

1.5 M of each allowance

6 (c) Explain various Robot configurations with neat sketch.

Different Robot Configurations:

Robots are being classified on the basis of their physical configuration and control systems adopted. These classifications are briefly described as below:



2 Marks for Detail Classification of Robot Configuration,

[1] Cartesian Configuration:

Robots having Cartesian configurations consist of links connected by linear joints (L). As the configuration has three perpendicular slides, they are also called rectilinear robots. Robot having a similar configuration is known as Gantry Robots. Its structure resembles a gantry type crane.

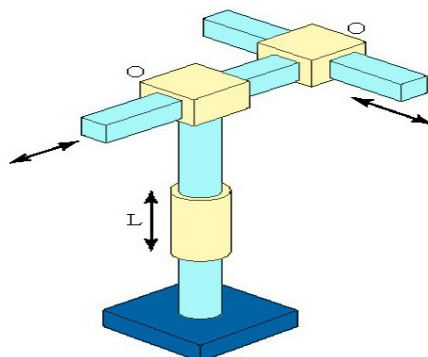


Figure: Cartesian (Standard and Gantry) Configuration

3 Marks for brief explanation of any 2 Robot Configuration,

[2] Cylindrical Configuration:

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.

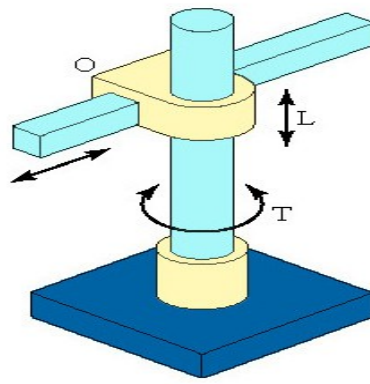


Figure: Cylindrical Configuration

[3] Polar (Spherical) Configuration

Polar robots have a work space of spherical shape. In general, the arm is linked to the base with a twisting (T) joint and rotatory (R) and or linear (L) joints. The designation of the arm for this arm can be TRL or TRR. Robots with the description of TRL are also called **spherical robots**.

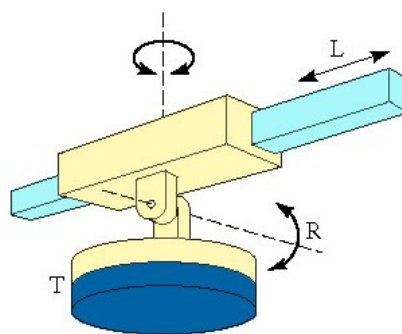


Figure: Polar (Spherical) Configuration

[4] Jointed Arm Configuration:

The combination of cylindrical and articulated configurations is known as jointed arm configuration. 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.

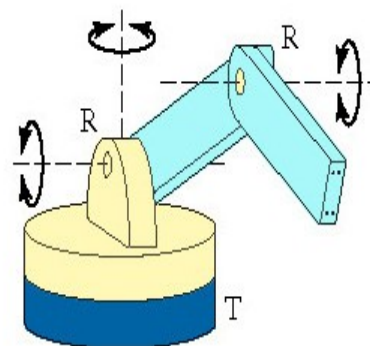


Figure: Jointed Arm Robot Configuration

(2 Marks for Detail Classification of Robot Configuration, 3 Marks for brief explanation of any 2 Robot Configuration, 3 Marks for neat sketches of any 2 Robot Configuration)

3 Marks for neat sketches of any 2 Robot Configuration