Scoring Indicators

COURSE NAME : Modern Production Process

COURSE CODE : 5023A

Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			9
I. 1	• Template jig • Plate jig • Leaf jig • Box jig • Channel jig • Ring jig • Indexing jig • Universal jig	Any 2 2 x 0.5	1	
I. 2	Powder metallurgy.		1	
I. 3	Electric discharge machining.		1	
I. 4	Electrochemical machining.		1	
I. 5	tool magazine system		1	
I. 6	M		1	
I. 7	Flexible manufacturing cell.		1	
I. 8	Indexing jig		1	
I. 9	Selective Compliance Articulated Robot Arm		1	
	PART B			24
II. 1	• Increased accuracy and repeatability of parts • Reduced setup time and machining time • Improved productivity and throughput • Reduced labour costs • Improved safety • Reduced scrap and rework • To reduce the cost of production. • Less skilled labour. • To enable heavy and combust shaped parts to be machined by being held rigidly to a machine.	Any 3	3	

II. 2	1. **Paints:** Paints are versatile organic coatings that come in various formulations, including water-based, solvent-based, and powder coatings. They are used for decorative purposes and to protect surfaces from corrosion, UV radiation, and wear. 2. **Varnishes:** Varnishes are clear or translucent organic coatings primarily applied to wood surfaces to enhance their appearance and provide protection against moisture, UV exposure, and abrasion. 3. **Enamels:** Enamels are a type of paint that forms a hard, glossy finish when applied. They are commonly used for decorative purposes on metal, wood, ceramics, and glass surfaces. 4. **Epoxy Coatings:** Epoxy coatings are highly durable and chemically resistant organic coatings used in various industrial applications, including as a protective layer for concrete floors, tanks, and pipes. 5. **Polyurethane Coatings:** Polyurethane coatings are known for their exceptional durability and resistance to abrasion, chemicals, and UV radiation. They are used in automotive finishes, furniture coatings, and industrial applications. 6. **Acrylic Coatings:** Acrylic coatings offer good weather resistance and are commonly used in outdoor applications, such as on building exteriors, signage, and automotive parts. 7. **Powder Coatings:** Powder coatings consist of finely ground particles of resin and pigment that are electrostatically applied to a substrate and then cured with heat. They are used for a wide range of applications, including metal furniture, appliances, and automotive parts. 8. **Lacquers:** Lacquers are fast-drying, clear or pigmented coatings that form a hard, durable finish. They are often used on wood, metal, and some plastic surfaces.	Any 3	3	
II. 3	1. Slow Material Removal: EDM is generally slower than traditional machining processes like milling or turning, making it less efficient for applications where rapid material removal is required.	Any 3	3	

	2. High Energy Consumption: EDM consumes a significant amount of electrical power, which can lead to higher operating costs, especially for large or complex parts. 3. Limited Material Compatibility: While EDM can cut a wide range of materials, it may struggle with certain conductive materials like aluminium and copper, which can be less efficient to machine due to their higher electrical conductivity. 4. Surface Finish and Recast Layer: EDM can leave a recast layer on the machined surface, which may require additional finishing operations to achieve the desired surface quality. This can add to production time and cost. 5. Tool Wear: The electrodes used in EDM wear over time, leading to the need for frequent tool changes, which can disrupt the machining process and require skilled labor for setup. 6. Complex Setup: Setting up EDM machines can be more complex compared to traditional machining methods, and it may require specialized knowledge and experience. 7. Limited Geometric Complexity: EDM is better suited for simple to moderately complex geometries. Highly intricate or 3D shapes can be challenging to machine with EDM. 8. Risk of Workpiece Damage: In certain cases, especially when machining very thin or delicate parts, there is a risk of workpiece damage due to the intense heat generated during the process. 9. Environmental Concerns: EDM produces hazardous waste in the form of sludge, which must be properly disposed of, adding to environmental considerations and costs. 10. Costly Machinery: The initial investment in EDM machines can be significant, making it less accessible for small-scale or budget-conscious manufacturing operations.			
II. 4	1. Material Versatility: Non-traditional machining methods are not limited by material hardness or conductivity. They can effectively machine a wide range of materials, including hard alloys, ceramics, and even heat-resistant materials.		3	

	2. High Precision: These methods can achieve exceptional levels of precision and accuracy, making them suitable for applications that demand tight tolerances and intricate details. 3. Complex Geometries: Non-traditional machining processes excel at machining complex and intricate shapes, including 3D contours and irregular profiles, which can be challenging for conventional methods. 4. Minimal Workpiece Stress: Since non-traditional machining methods are non-contact processes, they produce minimal mechanical stress, reducing the risk of workpiece deformation or damage, especially for delicate materials. 5. No Tool Wear: Unlike traditional machining, which involves cutting tools that wear out over time, non-traditional methods like EDM and laser cutting do not have tool wear issues, leading to consistent and repeatable results. 6. Little to No Cutting Forces: Non-traditional machining processes typically generate minimal cutting forces, reducing the need for robust and heavy machine structures. This can lead to cost savings in machine design and maintenance. 7. No Thermal Distortion: Non-traditional methods like waterjet cutting and EDM use non-thermal energy sources, preventing heat-related distortion or metallurgical changes in the workpiece.			
II. 5	Vertical Machining Center (VMC): In a VMC, the spindle with the cutting tool is oriented vertically. This design is well-suited for a wide range of applications and is commonly used for milling, drilling, and tapping operations. VMCs are known for their versatility and ability to handle a variety of workpiece sizes. 2. Horizontal Machining Center (HMC): In contrast to VMCs, HMCs have a horizontal spindle orientation. They are particularly useful for applications where multiple sides of a workpiece need machining, as they can offer improved access to various angles and surfaces. HMCs are often used in aerospace and automotive industries for high-precision and high-volume production.		3	

	3. Five-Axis Machining Center: A five-axis machining center has the ability to move the cutting tool along five different axes, typically X, Y, Z, and two rotary axes (A and B or C). This versatility allows for machining complex and contoured shapes from multiple angles, making it ideal for industries such as aerospace, medical, and mold-making where intricate and intricate parts are common.			
II. 6	• CNC Machining Produces Little to No Waste. • Zero Defects and Greater Accuracy. • Faster and Efficient Production. • Quicker Assembly. • Enhanced Personnel Safety. • Reduction in Energy Consumption. • CNC Machining Leads to Lower Production Costs.	Any 3	3	
II. 7	• Rotational joint • Linear joint • Twisting joint • Orthogonal joint • Revolving joint	Any 3	3	
II. 8	• 3 axis • 4 axis • 5 axis		3	
II.9	1. Material Handling in Manufacturing: AGVs are frequently used in manufacturing facilities to transport raw materials, work-in-progress, and finished products between different stages of production. 2. Warehousing and Distribution: AGVs are employed in warehouses and distribution centres to move pallets and goods between storage locations and loading docks, improving efficiency and reducing labour costs. 3. Order Picking: AGVs can be utilized for order picking in e-commerce and retail fulfilment centres, increasing the speed and accuracy of order processing.	Any 3	3	

	4. Container Transport: AGVs are often used in ports and container terminals to transport shipping containers within the facility, enhancing container handling operations. 5. Automated Storage and Retrieval Systems (AS/RS): AGVs are integrated with AS/RS systems to automatically retrieve and store items in high-bay racking systems. 6. Hospital Logistics: AGVs are used in hospitals to transport medications, linens, and medical equipment, ensuring timely delivery and reducing the risk of contamination. 7. Food and Beverage Industry: AGVs are employed in food and beverage production facilities to move ingredients and products, maintaining cleanliness and safety standards. 8. Agriculture: AGVs can be used in agriculture for tasks like crop harvesting, where they can navigate fields autonomously to gather crops.			
II.10	i) G00 (Rapid Positioning): The G00 code instructs the CNC machine to move the tool or workpiece at its maximum rapid traverse rate to a specified position. It's used for rapid, non-cutting movements between machining locations to reduce downtime. G00 is often used for tool changes, positioning the machine at the start point, or moving to a clear space for safe tool movement. ii) G81 (Drilling Cycle, Simple): G81 is a drilling cycle code. When this code is executed, the CNC machine will perform a drilling operation. It specifies the location and depth of the hole, and the machine will automatically retract the tool out of the hole once the drilling is complete. G81 is suitable for simple drilling operations with fixed depths. iii) G90 (Absolute Positioning): G90 sets the CNC machine to operate in absolute positioning mode. In this mode, all coordinate values entered are interpreted as absolute positions relative to the machine's zero point (usually its home or reference position). It provides a consistent reference point for all movements, which is especially useful for ensuring accurate positioning and avoiding cumulative errors in complex machining operations.		3	

<table>
<tr><td></td><td>PART C</td><td></td><td></td><td>42</td></tr>
<tr><td>III</td><td>
<table>
<tr><td>Sl. No.</td><td>Jig</td><td>Fixture</td></tr>
<tr><td>1</td><td>Hold the workpiece and guide the tool</td><td>Hold the workpiece but do not guide the tool</td></tr>
<tr><td>2</td><td>Used for drilling, boring, reaming</td><td>Used for milling, turning, grinding</td></tr>
<tr><td>3</td><td>More complex</td><td>Less complex</td></tr>
<tr><td>4</td><td>More expensive</td><td>Less expensive</td></tr>
<tr><td>5</td><td>More accurate</td><td>Less accurate</td></tr>
<tr><td>6</td><td>More repeatable</td><td>Less repeatable</td></tr>
<tr><td>7</td><td>Usually movable with the machine table</td><td>Clamped in the fixed position of the machine table</td></tr>
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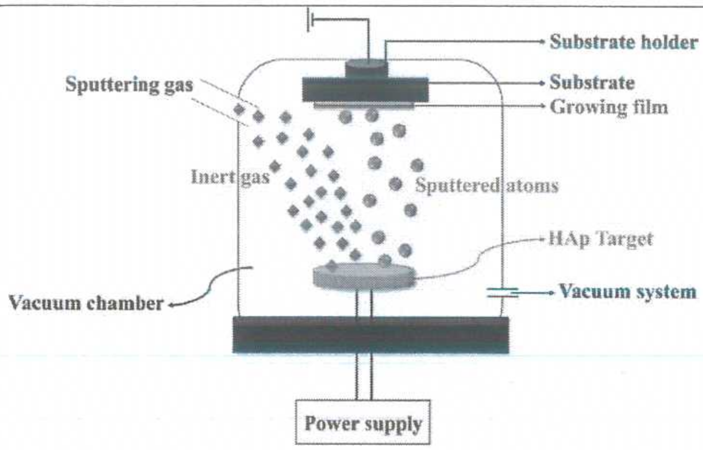
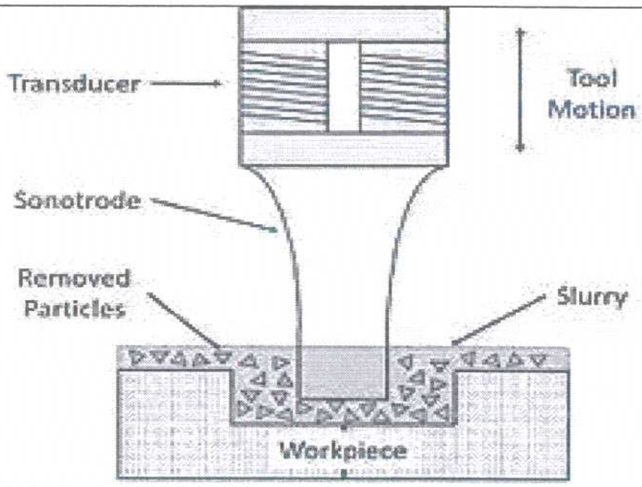
</td><td></td><td>7</td><td>7</td></tr>
<tr><td>IV</td><td>


Physical vapour deposition (PVD) is fundamentally a vaporisation coating technique, involving transfer of material on an atomic level. PVD processes are carried out under vacuum conditions. The process involved four steps:

- Evaporation
- Transportation
- Reaction
- Deposition

Evaporation

During this stage, a target, consisting of the material to be deposited is bombarded by a high energy source such as a beam of electrons or
</td><td>Fig: 3
Explanation-4</td><td>7</td><td>7</td></tr>
</table>

	ions. This dislodges atoms from the surface of the target, 'vaporising' them. **Transport** This process simply consists of the movement of 'vaporised' atoms from the target to the substrate to be coated and will generally be a straight-line affair. **Reaction** In some cases coatings will consist of metal oxides, nitrides, carbides and other such materials. In these cases, the target will consist of the metal. The atoms of metal will then react with the appropriate gas during the transport stage. **Deposition** This is the process of coating build up on the substrate surface.			
V	 **Principle:** It works on the same principle of ultrasonic welding. This machining uses ultrasonic waves to produce high frequency force of low amplitude, which act as driving force of abrasive. Ultrasonic machine generates high frequency vibrating wave of frequency about 20000 to 30000 Hz and amplitude about 25-50 micron. This high frequency vibration transfer to abrasive particle contains in abrasive slurry. This leads indentation of abrasive particle to brittle work piece and removes metal from the contact surface. **Magnetostrictive transducer:** As we know, transducer is a device which converts electric single into mechanical vibration. In ultrasonic machining magnetostrictive type		7	7

	transducer is used to generate mechanical vibration. This transducer is made by nickel or nickel alloy. **Booster:** The mechanical vibration generated by transducer is passes through booster which amplify it and supply to the horn. **Tool:** The tool used in ultrasonic machining should be such that indentation by abrasive particle, does not leads to brittle fracture of it. Thus the tool is made by tough, strong and ductile materials like steel, stainless steel etc. • First the low frequency electric current passes through electric supply. This low frequency current converts into high frequency current through some electrical equipment. • This high frequency current passes through transducer. The transducer converts this high frequency electric single into high frequency mechanical vibration. • This mechanical vibration passes through booster. The booster amplify this high frequency vibration and send to horn. • Horn which is also known as tool holder, transfer this amplified vibration to tool which makes tool vibrate at ultrasonic frequency. • As the tool vibrates, it makes abrasive particle to vibrate at this high frequency. This abrasive particle strikes to the work piece and remove metal form it. **Tool holder or Horn:** As the name implies this unit connects the tool to the transducer. It transfers amplified vibration from booster to the tool. It should have high endurance limit. **Abrasive Slurry:** A water based slurry of abrasive particle used as abrasive slurry in ultrasonic machining. Silicon carbide, aluminium oxide, boron carbide are used as abrasive particle in this slurry. A slurry delivery and return mechanism is also used in USM.			

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<tr><td>VI</td><td>

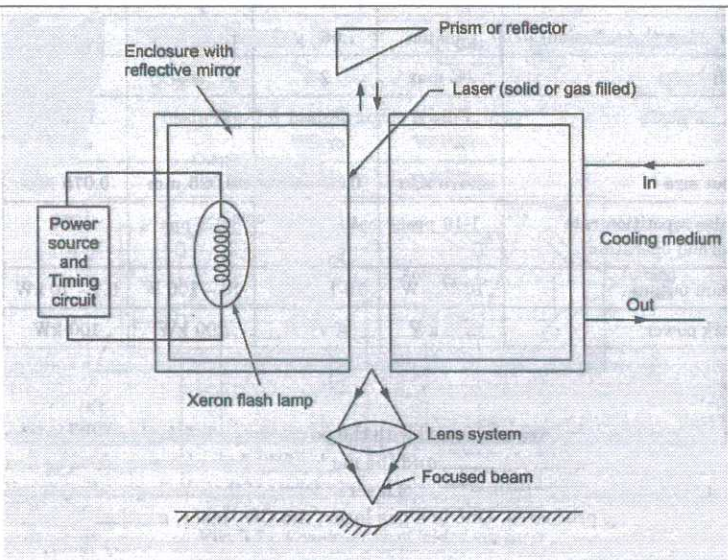

Fig. 7.8 *Laser Beam Machining*

LBM is a non-conventional machining process that uses a laser beam to remove material from a workpiece. The laser beam is a highly focused beam of light that has a very high energy density. When the laser beam strikes the workpiece surface, it melts and vaporizes the material.

The LBM process is controlled by a computer. The computer controls the position and power of the laser beam. The computer also controls the movement of the workpiece.

Applications

- LBM is used for making very small holes in hard materials.
- It can be used for mass micro-machining production.
- Also used for partial cutting or engraving.
- Electronics: LBM is used to machine circuit boards, semiconductor chips, and other electronic components.

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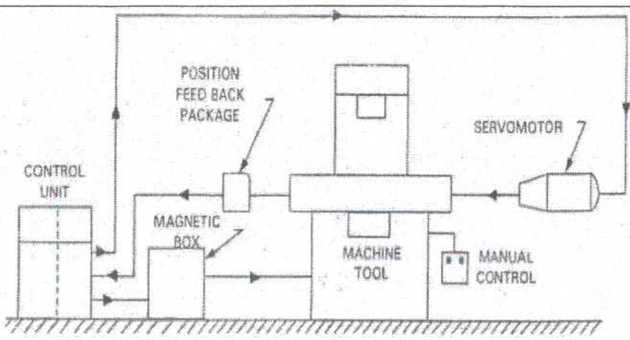
<tr><td>VII</td><td>



1. **Control unit:** The central component of an NC machine is the control unit. It is responsible for interpreting the part program, which contains the instructions for the machining operation. The

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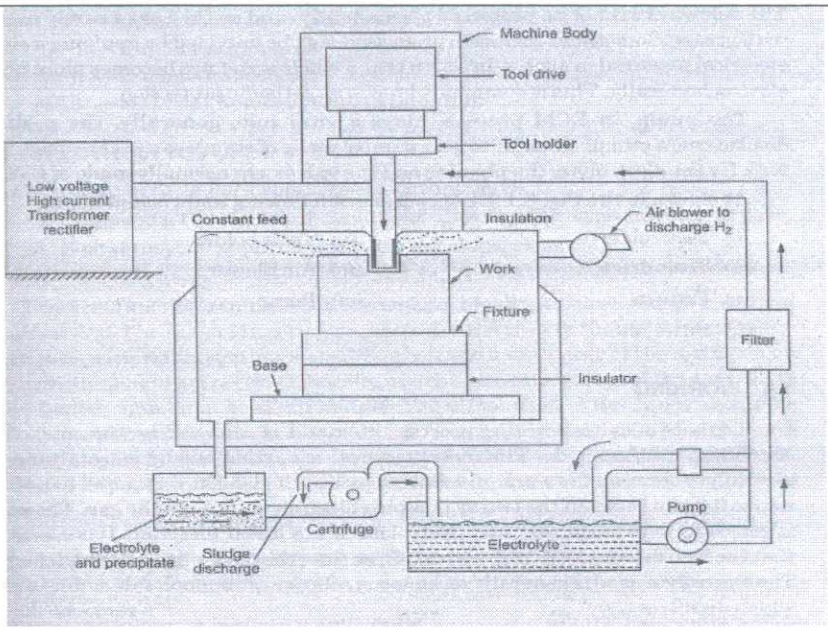
	computer processes these instructions and generates signals to control the machine's movements. 2. **Part Program:** The part program is a sequence of alphanumeric codes that specify the machining operations to be performed. 3. **Servo Motors:** Servo motors are responsible for moving the various components of the machine. 4. **Feedback Systems:** Feedback systems, which include encoders and sensors, provide real-time information about the position and speed of the machine's moving parts. 5. **Machine Tool:** These components perform the actual machining operations based on the instructions from the controller. 6. **Control Panel:** It provides a means for manual control and machine setup.			
VIII	**3D printing**, also known as additive manufacturing, is a revolutionary technology that allows the creation of three-dimensional objects by adding material layer by layer. It is a departure from traditional subtractive manufacturing processes, where material is removed from a solid block to create the desired shape. In 3D printing, objects are built up layer by layer from digital 3D models, offering numerous advantages and applications. **Key Components of 3D Printing:** 1. **Digital 3D Model:** The process starts with a digital 3D model created using computer-aided design (CAD) software or obtained from 3D scanning. 2. **3D Printer:** The 3D printer is the machine that executes the printing process. It reads the digital model and deposits material layer by layer to create the physical object. 3. **Printing Material:** Various materials can be used for 3D printing, including plastics, metals, ceramics, and composites, depending on the printer type and application. 4. **Printing Process:** 3D printing encompasses various printing technologies, such as Fused Deposition Modelling (FDM), Stereolithography (SLA), Selective Laser Sintering (SLS), and more.		7	7

IX	1. Computer Numerical Control (CNC) Machines: These are automated machining tools, such as CNC milling machines, lathes, and robots, which perform various manufacturing operations. 2. Central Computer Control: A central computer or controller that manages and coordinates the operation of the entire FMS. 3. Automated Material Handling System: This component includes conveyor systems, robots, and automated guided vehicles (AGVs) that transport materials and workpieces between machines and workstations. 4. Workstations: These are stations where specific manufacturing tasks are performed, often equipped with CNC machines or robotic arms. 5. Inventory Control System: Software and hardware for managing raw materials, work-in-progress, and finished goods inventory. 6. Quality Control Systems: Sensors, cameras, and inspection equipment to monitor and ensure product quality. 7. Human-Machine Interface (HMI): User interfaces, often touchscreen displays, for operators and engineers to monitor and control the FMS. 8. Material Handling and Storage Control Software: Software that manages the movement and storage of materials within the system. 9. Safety Systems: Safety features like emergency stops, safety interlocks, and barriers to protect workers and equipment. 10. Maintenance and Diagnostics Systems: Tools for monitoring the health of machines and scheduling maintenance to minimize downtime. 11. Robotics and Automation: Robotic arms and automation systems for tasks such as loading/unloading machines and material handling.		7	7
X	**Material Handling:** Robots are utilised to load and unload machine tools.		7	7

	Welding: Welding is a manufacturing process in which two pieces of metal are joined usually by heating and fusing **Spray Painting** **Assembling** **Machining** **Medical**: Medical robots have found applications mainly in surgery **Mining**: In order to enhance productivity, access unworkable mineral seams, and reduce human exposure to the inhospitable environment of dust, noise, gas, water, moving equipment and robots are used			

XI	Non-conventional machining processes are manufacturing methods used to remove material from a workpiece that cannot be easily achieved through traditional machining methods like turning, milling, or drilling. **Significance of Non-Conventional Machining Processes**: **Material Versatility**: It can be applied to a wide range of materials, including hard and brittle materials like ceramics, composites, and heat-resistant alloys, which are difficult to machine using conventional methods. **Precision and Intricacy**: These processes can achieve high levels of precision and intricate shapes. **Minimal Heat Generation**: Unlike traditional machining, non-conventional methods typically produce minimal heat. **Minimal Tool Wear**: Many non-conventional processes use non-contact methods (e.g., electrical discharge machining) or abrasive methods (e.g., abrasive water jet machining), resulting in less tool wear and longer tool life. **Complex Geometries**: They enable the production of complex and irregular shapes, including internal cavities and undercuts, which are challenging to achieve with traditional methods. **Classification of Non-Conventional Machining Processes:** Electrical Discharge Machining (EDM) Electrochemical Machining (ECM) Abrasive water Jet Machining (AWJM) Ultrasonic Machining (USM) Laser Beam Machining (LBM).		7	7

XII	 **Working** ECM is a non-conventional machining process that uses an electrochemical reaction to remove material from a workpiece. The workpiece is connected to the positive terminal of a DC power supply, and the tool is connected to the negative terminal. The electrolyte is a solution of conductive ions, such as sodium chloride. When the current is turned on, the ions in the electrolyte flow from the tool to the workpiece. At the workpiece surface, the ions react with the metal to form metal ions and electrons. The metal ions are dissolved into the electrolyte, and the electrons flow through the power supply to the tool. **ECM Process Applications** • Aerospace: ECM is used to machine turbine blades, compressor blades, and other aerospace components. • Automotive: ECM is used to machine engine blocks, transmission gears, and other automotive components. • Medical: ECM is used to machine surgical implants, dental crowns, and other medical devices. • Electronics: ECM is used to machine circuit boards, semiconductor chips, and other electronic components. • Oil and gas: ECM is used to machine drill bits and other oil and gas components. • Food and beverage: ECM is used to machine food processing equipment and beverage packaging equipment.		7	7
XIII	Nine major elements of a CIM system are		7	7

	i. Marketing: The need for a product is identified by the marketing division. ii. Product Design: The design department of the company establishes the initial database for production of a proposed product. In a CIM system this is accomplished through activities such as geometric modelling and computer aided design while considering the product requirements and concepts generated by the creativity of the design engineer. iii. Planning: The planning department takes the database established by the design department and enriches it with production data and information to produce a plan for the production of the product. iv. Purchase: The purchase departments is responsible for placing the purchase orders and follow up, ensure quality in the production process. v. Manufacturing Engineering: Manufacturing Engineering is the activities like CNC programming, simulation and computer aided scheduling of the production activity. vi. Factory Automation Hardware: Factory automation equipment further enriches the database with equipment and process data, resident either in the operator or the equipment to carry out the production process. vii. Warehousing: Warehousing is the function involving storage and retrieval of raw materials, components, finished goods as well as shipment of items. viii. Finance: Finance deals with the resources pertaining to money. ix. Information Management: Information Management involves master production scheduling, database management, communication, manufacturing systems integration and management information systems			
XIV	Mechanical platforms or hardware base is a mechanical device, such as a wheeled platform, arm, fixed frame or other construction, capable of interacting with its environment. and any other mechanism involve with his capabilities and uses. • Sensors systems is a special feature that rest on or around the robot. This device would be able to provide judgment to the controller with relevant information about the environment and give useful feedback to the robot.		7	7

	• Joints provide more versatility to the robot itself and are not just a point that connects two links or parts that can flex, rotate, revolve and translate. • Controller functions as the "brain" of the robot. Robots today have controllers that are run by programs - sets of instructions written in code. • Power Source is the main source of energy to fulfil all the robots needs. • Artificial intelligence represents the ability of computers to "think" in ways similar to human beings. • Actuators are the muscles of robot.			