

194

20

COURSE NAME : MODERN PRODUCTION PROCESS

COURSE CODE : 5023A (21)

QID :

PART A

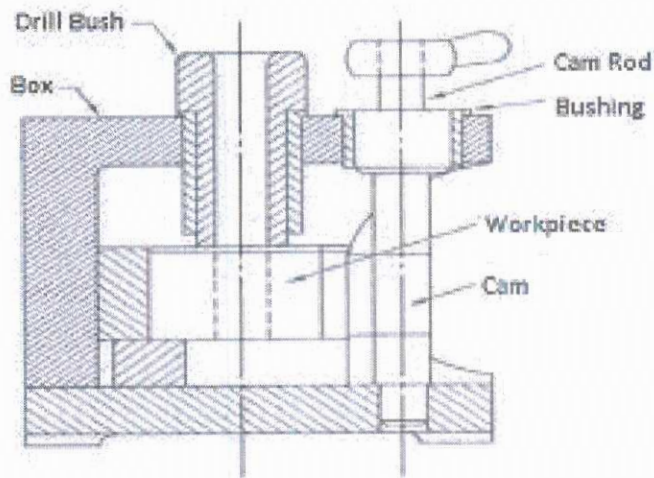
I. Answer all the following questions in one word or sentence.

(9 x 1 = 9 Marks)

Max. marks

Q.No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			24
I.1	<ol style="list-style-type: none">1. Milling Fixtures:2. Turning Fixtures:3. Drilling Fixtures:4. Welding Fixtures:5. Assembly Fixtures:6. Indexing Fixtures:	ANY 2x1/2	1	
I.2	Diffusion coating is a specialized surface coating process used to improve the properties of a substrate material by introducing specific elements into its surface through diffusion.	1	1	
I.3	Coolant: Flush Medium: Electrical Insulation: Chip Removal: Electrode Erosion Control:	ANY 2x1/2	1	
I.4	Material Removal Rate refers to the volume of material that is removed or machined from a workpiece in a given period of time.	1	1	
I.5	G codes are primarily used to control the motion and positioning of the CNC machine's tool and workpiece during machining operations. They specify the type of motion, such as linear or circular, and the coordinates for the tool's movement.	1/2	1	

	M codes are used to control various auxiliary functions and actions of the CNC machine. They handle tasks such as tool changes, coolant control, spindle control, and other machine-specific operations.	1/2	1	
I.6	Cost: Size Limitations: Layer Lines: Speed of Production:	DNY $2 \times \frac{1}{2}$ $= 1$	1	
I.7	CAD (Computer Aided Design): CAM (Computer Aided Manufacturing): COMPUTER INTEGRATED MANUFACTURING	1	1	
I.8	Setup Time: Energy Consumption: Slow Material Removal Rate: Tool Wear and Maintenance: Complexity and Specialization: Limited Material Compatibility:	DNY $2 \times \frac{1}{2}$ $= 1$	1	
I.9	An Automatic Tool Changer (ATC) is a device or mechanism used in CNC (Computer Numerical Control) machining systems to automatically change cutting tools or machining accessories without manual intervention.	1	1	
PART B				24
II.1	A box-type jig is a type of workholding and guiding device used to secure and accurately position a workpiece during machining operations. It is called a "box-type" jig because of its characteristic enclosed or boxed structure, which provides stability and support to the workpiece from multiple sides. Box-type jigs are commonly used in drilling, reaming, tapping, and boring operations where precision and repeatability are crucial.	2		



BOX JIG

1

3

The key differences between jigs and fixtures:

1. Function:

- **Jig:** A jig is a tool used to guide and control the motion or location of a cutting tool during a machining operation
- **Fixture:** A fixture is a tool used to securely hold and support the workpiece during a machining or manufacturing process.

2. Primary Purpose:

- **Jig:** The primary purpose of a jig is to ensure the accuracy of the machining operation.
- **Fixture:** The primary purpose of a fixture is to hold the workpiece securely and provide stability during machining.

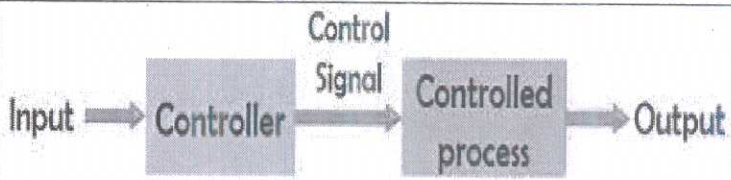
3. Contact Points:

- **Jig:** A jig typically makes contact with the cutting tool, guiding and directing its movement. It does not directly contact the workpiece.
- **Fixture:** A fixture makes direct contact with the workpiece, holding it in place and

any
3x1
= 3

II.2

	6. Electronics and Semiconductors: 7. Mold and Die Making: 8. Prototyping: 9. Additive Manufacturing (3D Printing): 10. Cutting and Welding of Thin Foils: 11. Optical and Photonic Devices: 12. Rapid Tooling:		3	
II.5	Limitations of CNC machining: <ol style="list-style-type: none"> 1. Initial Cost: 2. Complex Programming: 3. Skill Requirement: 4. Maintenance and Downtime: 5. Limited Flexibility: 6. Material Limitations: 7. Tool Wear: 8. Size and Weight Limitations: 9. Surface Finish: 10. Energy Consumption: 11. Waste of Material: 12. Noise and Vibration: 	DNT GXY ₂ = 3	3	
II.6	<ol style="list-style-type: none"> 1. Product Design and Development: 2. Aerospace and Aviation: 3. Automotive Industry: 4. Medical and Healthcare: 5. Consumer Electronics: 6. Architecture and Construction: 7. Tooling and Manufacturing: 8. Education and Research: 9. Military and Defense: 	DNT GXY ₂ = 3	3	
II.7	<ol style="list-style-type: none"> 1. Open-Loop CNC Systems: <ul style="list-style-type: none"> • In open-loop CNC systems, the control unit sends commands to the motors and actuators without receiving feedback about the actual position or status of the machine. • These systems do not have a feedback mechanism to verify whether the commanded movements have been executed accurately. • They are typically used for simple and less critical machining operations where high precision is not essential. 	2.5		

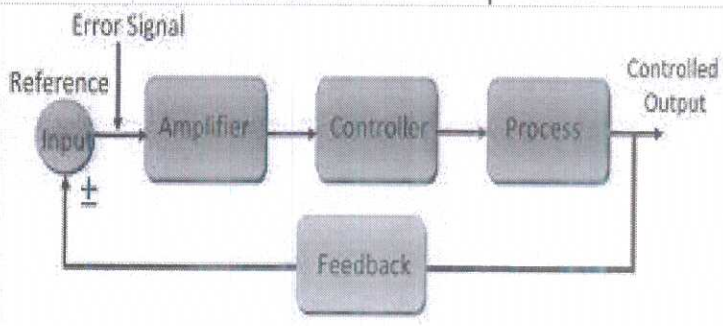


Open Loop Control System

Electronics Coach

2. Closed-Loop CNC Systems:

- Closed-loop CNC systems, also known as feedback or servomechanism-based CNC systems, include feedback devices such as encoders and resolvers.
- These systems continuously monitor the actual position and status of the machine's components and compare them to the desired position.



Closed Loop Control System

Circuit Globe

Fig 1

2.5

7

Fig 1

II.8

1. **Manufacturing and Assembly:**
2. **Material Handling and Warehousing:**
3. **Machine Operation:**
4. **Palletizing and Depalletizing:**
5. **Quality Control and Inspection:**
6. **Welding and Fabrication:**
7. **Electronics Manufacturing:**
8. **Aerospace and Defense:**
9. **Construction:**
10. **Energy :**
11. **Agriculture:**

ANY
6x2
=3

3

II.9

It is a self-contained and semi-autonomous manufacturing unit that combines one or more machine tools with ancillary equipment and automation systems

1.5

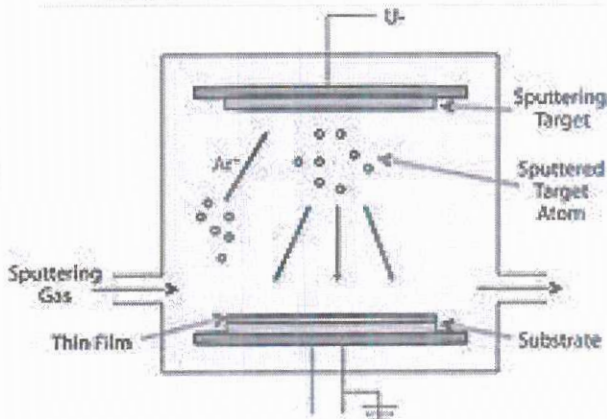
	<p>to complete a specific set of machining operations. It helps to streamline and optimize the production process for a particular group of parts or components.</p> <p>Key Characteristics:</p> <ol style="list-style-type: none"> 1. Focused Production: 2. Self-Contained: 3. Automation: 4. Integrated Controls: 5. Quick Changeovers: 	1.5	3	
II.10	<p>It refers to a group of products or components that share similar characteristics such as design, materials, manufacturing processes, and functionality. This allows for the grouping of parts into families, simplifying production planning, tooling, and manufacturing processes. Part families help in improving efficiency and reducing costs. Here are some key aspects of part families:</p> <ol style="list-style-type: none"> 1. Common Characteristics: 2. Grouping and Classification: 3. Efficient Manufacturing: 4. Standardization: 5. Reduced Changeovers: 6. Improved Quality Control 7. Flexibility: 8. Inventory Management: 9. Cost Reduction: 10. Product Variety: 	1	3	
	PART C			42
III	Physical Vapor Deposition (PVD) is a process that involves the deposition of material in a vacuum			

ANY
 $4 \times \frac{1}{2}$
 $= 2$

environment to create thin layers or coatings on a substrate..

PVD methods typically involve one of two primary techniques: evaporation or sputtering.

- **Evaporation:** In this method, a solid material (the target or source material) is heated to its vaporization temperature within a vacuum chamber. As it evaporates, the vaporized atoms or molecules travel through the vacuum and condense on the substrate, forming a thin film.
- **Sputtering:** In sputtering, a high-energy plasma or ion beam bombards the target material, causing atoms or molecules to be ejected from the target's surface. These ejected particles then deposit onto the substrate



3

fig 1

7

Chemical Vapor Deposition (CVD) is a thin-film deposition technique used to produce high-quality films, coatings, and layers of various materials on substrates. CVD involves chemical reactions in the vapor phase to create the desired film.

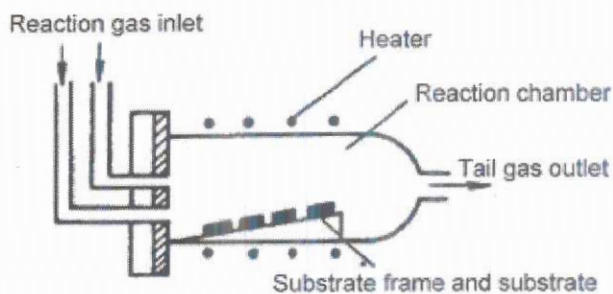


fig 1

The substrate onto which the film will be deposited is



placed inside a reactor chamber. The substrate is often cleaned and heated to a specific temperature to improve adhesion and promote the chemical reactions.

Fixtures used in turning:

1. Three-Jaw Chuck:

- A three-jaw chuck is one of the most common fixtures used in lathe turning operations.
- It consists of three adjustable jaws that can move simultaneously to grip the workpiece.
- Three-jaw chucks are versatile and can hold both round and hexagonal workpieces.

2. Four-Jaw Chuck:

- A four-jaw chuck has four independently adjustable jaws, allowing for more precise centering and gripping of irregularly shaped workpieces.
- It is suitable for holding square, rectangular, and irregularly shaped workpieces.

3. Collet Chuck:

- Collet chucks use collets, which are specialized holding devices that can grip workpieces with high precision.
- They are commonly used for small-diameter workpieces, such as shafts and small rods.
- Collets come in various sizes to accommodate different workpiece diameters.

4. Faceplate:

- A faceplate is a flat circular fixture that attaches to the lathe spindle.
- It is used for holding larger and heavier workpieces, such as discs or rings.
- Workpieces are secured to the faceplate using bolts or clamps.

IV

ANY
3x2
=6

fig 1

	<p>5. Mandrel:</p> <ul style="list-style-type: none"> • A mandrel is a cylindrical fixture that fits inside the workpiece to support it during machining. • It is commonly used for thin-walled or tubular workpieces, such as pipes and tubes. • The mandrel's outer diameter matches the internal diameter of the workpiece. <p>6. Fixture Plates and Clamps:</p> <ul style="list-style-type: none"> • Fixture plates with clamps are used for securing irregularly shaped or non-symmetrical workpieces. • The fixture plate can be customized with various clamps, bolts, and locating pins to hold the workpiece securely. <p>7. Indexing Fixture:</p> <ul style="list-style-type: none"> • An indexing fixture is used for machining workpieces with multiple faces or features that require precise angular positioning. • It allows for indexing or rotating the workpiece to specific angles for machining. <p>8. Chucking Fixture:</p> <ul style="list-style-type: none"> • Chucking fixtures are specialized fixtures designed for holding and machining workpieces with complex shapes. • They can include custom-designed jaws, pins, and clamps to secure the workpiece in the desired orientation. 			
V	<p>ECM utilizes the principles of electrochemistry to remove material from a workpiece. It is particularly useful for machining complex shapes and hard-to-machine materials. ECM relies on the controlled electrochemical dissolution of the workpiece material through the interaction of an electrolyte solution and an electrode tool.</p>			

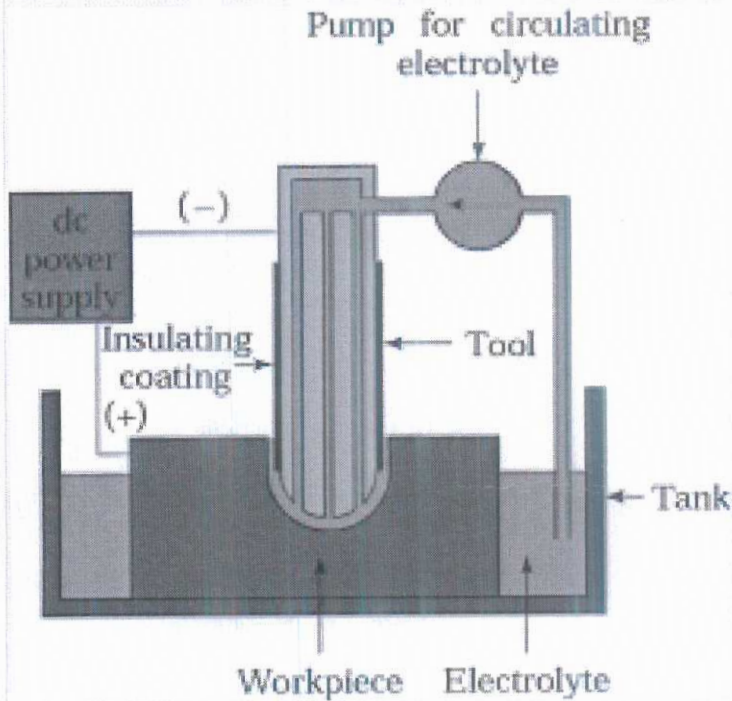


fig
2

Process Description:

1. **Workpiece and Electrode Tool:** In ECM, a workpiece and an electrode tool (typically made of a conductive material like copper or brass) are submerged in an electrolyte solution.
2. **Electrolyte Solution:** The electrolyte is a conductive solution, often consisting of an electrolyte salt mixed with water or another solvent.
3. **Electrical Connection:** The workpiece and tool are electrically connected to a power supply.
4. **Electrochemical Reactions:** When a voltage is applied across the workpiece and tool, electrochemical reactions occur at the workpiece's surface.
5. **Material Removal:** As the electrochemical reactions continue, material is removed from the workpiece in the form of metal ions. The controlled flow of the electrolyte carries away these ions and debris from the machining area.

3

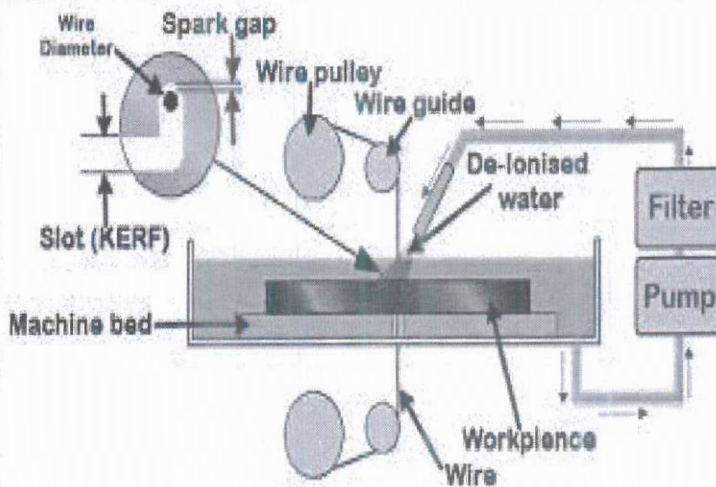
Applications:

1. **Aerospace Industry:**
2. **Medical Device Manufacturing:**
3. **Automotive Industry:**
4. **Electronics:**
5. **Dies and Molds:**
6. **Tool and Cutter Manufacturing:**
7. **Research and Development:**

AN7
 $4 \times \frac{1}{2}$
 $= 2$

7

Wire Cut Electrical Discharge Machining (Wire EDM or WEDM) is a non-conventional machining process used for precision cutting and shaping of conductive materials, including metals and alloys. The working principle of Wire cut EDM involves the controlled erosion of material through electrical discharges or sparks. Here's a step-by-step explanation of how Wire EDM works:



VI

2

1. Setup:

- A workpiece, often made of electrically conductive material, is securely fixed to the machine's worktable.

2. Dielectric Fluid:

- The workpiece and the wire electrode are submerged in a dielectric fluid, typically deionized water or a special EDM oil.

3

3. Electrode Approach:

	<ul style="list-style-type: none"> The wire electrode is brought close to the workpiece surface, maintaining a small gap (spark gap) between them. The spark gap is typically controlled by a servo system that precisely positions the wire. <p>4. Electrical Discharge:</p> <ul style="list-style-type: none"> When the spark gap reaches a critical distance (usually a few micrometers), a high-frequency electrical pulse is applied to the wire electrode. <p>5. Erosion and Material Removal:</p> <ul style="list-style-type: none"> As the electrical discharge occurs, material from the workpiece is vaporized and removed from the surface. The dielectric fluid helps carry away the eroded particles. <p><u>Applications</u></p> <ul style="list-style-type: none"> Die and Mold Making: Aerospace Components: Medical Device Manufacturing: Automotive Parts: Electronics and Microelectronics: Prototype Development: Aircraft and Aerospace Tooling: Automated Machinery Components: Firearms and Defense: Energy Sector: Agricultural Equipment: 	<p>DNY $4XY_2$ $=$ 2</p>		
VII	<p>A tool magazine is a critical component of CNC (Computer Numerical Control) machining centers and CNC milling machines. It serves the essential purpose of storing and managing cutting tools used during the machining process. The significance of a tool magazine in CNC machining includes:</p> <ol style="list-style-type: none"> Tool Storage: Quick Tool Changes: 	<p>1</p>		

	<ol style="list-style-type: none"> 3. Reduced Manual Intervention: 4. Tool Variety: 5. Increased Machining Capacity: 6. Consistency: 7. Tool Management: 8. Space Efficiency: 9. Reduction in Setup Time: 10. Enhanced Safety: 11. 24/7 Operation: 12. Customization: <p>Common types of tool magazines:</p> <ol style="list-style-type: none"> 1. Umbrella Tool Magazine: 2. Drum or Carousel Tool Magazine: 3. Chain or Arm-Type Tool Magazine: 4. Random-Access Tool Magazine: 5. Robot-Integrated Tool Magazine: 	<p>DNY 6x2 =3</p>	<p>7</p>	
VIII	<p>M codes are special commands that instruct the CNC machine to perform various auxiliary functions or operations. M codes are used to control processes such as tool changes, coolant flow, spindle speed, and other miscellaneous functions.</p> <ol style="list-style-type: none"> 1. M00: Program Stop 2. M01: Optional Program Stop 3. M02: Program End 4. M03: Spindle On, Clockwise 5. M04: Spindle On, Counterclockwise 6. M05: Spindle Stop 7. M06: Tool Change 8. M07: Coolant On (Mist) 9. M08: Coolant On (Flood) 10. M09: Coolant Off 	<p>2</p> <p>DNY 5x1 =5</p>	<p>7</p>	
IX	<p>A robot's anatomy:</p> <ol style="list-style-type: none"> 1. Controller: <ul style="list-style-type: none"> • The controller or "brain" of the robot is typically a computer or microcontroller that processes information from sensors, executes control algorithms, and makes 	<p>1</p>		

decisions about the robot's actions.

2. **Sensors:**

- Sensors are used to collect data about the robot's environment and its own internal state. Common sensors include:
 - **Proximity Sensors:** Detect the presence of objects in the robot's vicinity.
 - **Vision Sensors/Cameras:** Capture visual information.

3. **Actuators:**

- Actuators are responsible for moving the robot's various components. Common types of actuators include:
 - **Electric Motors:** Drive wheels, arms, or other moving parts.
 - **Pneumatic Actuators:** Use compressed air to create motion.
 - **Hydraulic Actuators:** Use pressurized fluid to create motion.

4. **End Effectors:**

- End effectors are the tools or manipulators attached to the robot's arms or limbs. They are used to interact with the environment and perform tasks. Examples include grippers, welding torches, cutting tools, and 3D printing heads.

5. **Joints:**

- Joints are the mechanical connections between different parts of the robot, allowing them to move relative to each other. Depending on the robot's design, joints can be rotary (allowing rotation) or linear (allowing linear motion).

6. **Power Source:**

- Robots require a source of power to operate. This can be in the form of batteries, electric power from an outlet, hydraulics, or pneumatics,

	<p>depending on the robot's design and intended use.</p> <ul style="list-style-type: none"> external devices or systems, including human operators. <p>7. Safety Features:</p> <ul style="list-style-type: none"> Safety features like emergency stop buttons, collision detection systems, and protective barriers are essential to ensure the safe operation of robots, especially in industrial settings. 	1	7	
X	<p>FMC stands for "Flexible Manufacturing Cell. It is an integrated and automated production system used in manufacturing industries to enhance production flexibility, and efficiency. FMCs are designed to handle various tasks and adapt to different manufacturing processes without the need for extensive reconfiguration.</p> <p>The key components and features of an FMC:</p> <ol style="list-style-type: none"> Workstations: Material Handling System: Computer Control System: Flexibility: Integration: Quick Changeovers: High Efficiency: Reduced Labor Requirements: Quality Control: Scalability: Real-Time Monitoring: Energy Efficiency: 	2		
XI	<p>Classification of non-conventional machining processes:</p> <ol style="list-style-type: none"> Thermal Energy-Based Processes: <ol style="list-style-type: none"> Electrical Discharge Machining (EDM): Laser Beam Machining (LBM): 			

2NY
5x1
=5

1/2 + 1/2

2. Chemical and Electrochemical Processes:

a. **Electrochemical Machining (ECM)**

1

3. Mechanical Energy-Based Processes:

a. **Ultrasonic Machining (USM)**

b. **Abrasive Water Jet Machining (AWJM):**

1+1

The key advantages of non-conventional machining processes:

1. **Precision:**
2. **Complex Geometry:**
3. **No Tool Wear:**
4. **Minimal Material Wastage:**
5. **High Surface Finish:**
6. **Low Cutting Forces:**
7. **Automation Compatibility:**
8. **Machining of Heat-Resistant Materials:**
9. **No Cutting Fluids Required:**

any
6x1/2
23

Principle of Electrochemical Machining (ECM): In ECM, material removal occurs through the controlled electrochemical dissolution of the workpiece material.

The process involves the interaction between an electrolyte (usually a conductive salt solution) and a tool, which is typically made of a similar material to the workpiece but acts as the cathode.

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XII

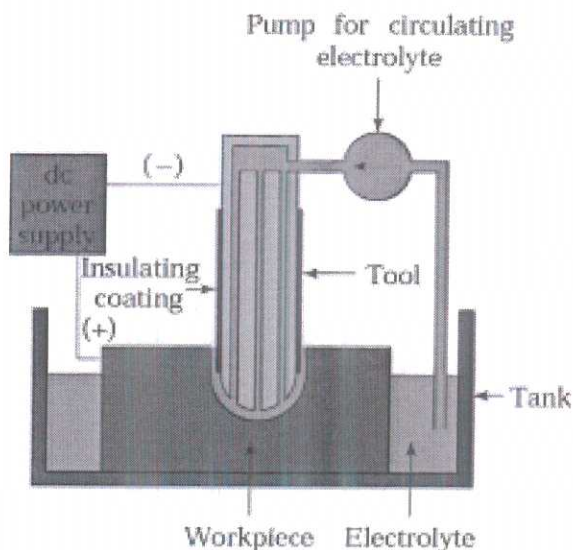


Fig 2

	<p>Components of ECM:</p> <ol style="list-style-type: none"> Workpiece: The workpiece is the material to be machined, and it is typically connected to the positive terminal (anode) of the power supply. Tool (Electrode): The tool, often made of the same material as the workpiece, serves as the cathode and is connected to the negative terminal of the power supply. Electrolyte: An electrolyte, which is a conductive solution, is continuously supplied between the workpiece and the tool. It acts as an electrolytic medium for ion transport. Power Supply: A DC power supply is used to create an electrical potential difference between the workpiece and the tool. This potential difference drives the electrochemical dissolution process. 	<p>) </p>		
<p>XIII</p>	<p>1. Group Technology (GT) involves classifying similar parts or products into groups based on their similarities in design, manufacturing processes, and characteristics. The goal of GT is to enhance efficiency, reduce production lead times, and improve overall productivity:</p> <p>Benefits of Group Technology:</p> <ol style="list-style-type: none"> Improved Efficiency: Lower Costs: Enhanced Quality: Flexibility: Simplified Planning: Reduced Lead Times: Higher Machine Utilization: Customization: <p>Part family in manufacturing refers to a group of parts or products that share common characteristics, such as design features,</p>	<p>2</p> <p>ANY 6x1/2 = 3</p> <p>2</p>		

	<p>manufacturing processes, materials, or dimensions. These similarities make it possible to group these parts together for various purposes, including production planning, scheduling, process optimization, and inventory management.</p>			
XIV	<p>The most common types of robot joints:</p> <ol style="list-style-type: none"> 1. Revolute Joint (R-Joint): <ul style="list-style-type: none"> • Also known as a rotary joint, the revolute joint allows rotational movement around a single axis. • It is one of the most common types of joints in robotic arms, resembling the movement of a human arm's elbow or knee. 2. Prismatic Joint (P-Joint): <ul style="list-style-type: none"> • A prismatic joint allows linear or translational movement along a single axis. • This type of joint is often used in robotic systems to create linear motion in robot grippers or sliding mechanisms. 3. Spherical Joint (S-Joint): <ul style="list-style-type: none"> • A spherical joint allows rotation in multiple axes simultaneously. • It offers three degrees of freedom (DOF) and is commonly used at the base of a robotic arm to provide orientation flexibility. 4. Cylindrical Joint (C-Joint): <ul style="list-style-type: none"> • A cylindrical joint combines translational (prismatic) and rotational (revolute) motion. • It allows linear movement along one axis and rotation around a perpendicular axis. 5. Continuous (Rotary) Joint: <ul style="list-style-type: none"> • Continuous or rotary joints allow continuous rotation without any limits. 	<p>ANY 4</p>		

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	<p>6. Universal Joint (U-Joint):</p> <ul style="list-style-type: none">• A universal joint, also known as a Cardan joint, provides two non-parallel rotational axes.			
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