TASK 2: Robotic Arm Simulation – Design Explanation

1. Objective of the Design

The objective is to design a **simple robotic arm** capable of performing a **pick-and-place operation**. The arm should have defined **degrees of freedom (DOF)** and basic motion simulation.

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2. Type of Robotic Arm Selected

A **4-DOF articulated robotic arm** is selected because:

- It is easy to design and simulate
- Commonly used in industrial pick-and-place tasks
- Demonstrates rotational and vertical movement clearly

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3. Parts of the Robotic Arm Design

3.1 Base

- Fixed circular or square base
- Mounted on ground
- Provides stability to the arm
- Allows rotation of the arm

3.2 Shoulder Link

- Connected to the base
- Performs up and down rotational motion
- Controls arm elevation

3.3 Elbow Link

- Connected to the shoulder
- Bends forward and backward
- Extends the reach of the arm

3.4 Wrist

- Attached at the end of elbow
- Provides orientation control

- Helps in accurate object placement

3.5 Gripper (End Effector)

- Two-finger mechanical gripper
- Used to pick and release objects
- Opens and closes using simple motion constraint

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4. Degrees of Freedom (DOF)

The robotic arm has **4 Degrees of Freedom**:

1. **DOF 1 – Base Rotation**
    - Rotation around vertical axis
    - Range: 0° to 360°
    - Purpose: Left-right positioning
2. **DOF 2 – Shoulder Joint**
    - Up-down rotation
    - Range: 0° to 90°
    - Purpose: Lifting and lowering the arm
3. **DOF 3 – Elbow Joint**
    - Forward-backward rotation
    - Range: 0° to 120°
    - Purpose: Extending and retracting reach
4. **DOF 4 – Gripper Motion**
    - Open and close movement
    - Purpose: Pick and place object

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5. Software Used for Design (Example)

You can use **any one**:

- AutoCAD (2D or 3D)
- SolidWorks
- Fusion 360
- Any robotic simulation software

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6. Design Steps in Software

Step 1: Base Modeling

- Draw a circular or square base

- Fix it using **ground constraint**

Step 2: Shoulder Link

- Create a rectangular link
- Add **revolute joint** with base

Step 3: Elbow Link

- Attach second link to shoulder
- Apply **rotational constraint**

Step 4: Wrist and Gripper

- Add wrist joint
- Design simple two-finger gripper
- Apply **linear or rotational constraint**

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7. Motion Simulation (Pick-and-Place)

Step-by-Step Motion Sequence

1. **Base rotates** toward the object
2. **Shoulder moves downward**
3. **Elbow extends** to reach object
4. **Gripper closes** to pick object
5. **Shoulder lifts arm**
6. **Base rotates** toward target position
7. **Elbow lowers**
8. **Gripper opens** to place object

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8. Simulation Constraints Used

- Revolute joints for rotation
- Angle limits for safety
- Fixed base constraint
- Motion motor for joints

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9. Applications of This Robotic Arm

- Industrial pick-and-place
- Assembly line automation

- Material handling
- Educational robotics training

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10. Conclusion

The designed **4-DOF robotic arm** successfully demonstrates basic robotic principles such as joint motion, degrees of freedom, and pick-and-place operation. The design is simple, cost-effective, and suitable for simulation in standard CAD software.