

# Practical Robotics Projects with Arduino

## End-Term Project Synopsis

Group No.	Group Members (Regd. No.)	Project Title
07	2241016206	Arduino Robotic Arm
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	2241003197	
	2241011233	
	2241016203	

### 1. Introduction: (Details about the Topic, industry, products, need of study and some history about the same etc.)

A robotic arm is a programmable mechanical manipulator used to perform tasks such as pick-and-place, sorting, assembly, and testing. These arms are widely used in manufacturing, packaging, education and research because they improve repeatability, speed, and safety for repetitive or hazardous tasks.

This project implements a low-cost, Arduino-based 4-DOF robotic arm built from a commercial mechanical arm kit and controlled by an Arduino UNO together with a PCA9685 PWM servo driver. Using the PCA9685 allows independent, stable PWM control of multiple servos while keeping the Arduino safe from high current draw. The platform is intended as both an educational prototype and a proof-of-concept for light automation tasks in small workshops or teaching labs.

### 2. Problem identification and Problem Formulation: (Core area of problems or other related problems and their brief solutions)

#### Problem Identification

- Full industrial robotic arms are expensive and complex, making hands-on learning and small-scale automation inaccessible for many students, hobbyists, and small businesses.
- Directly driving multiple servos from an Arduino can cause power instability, jitter, and risk of overcurrent from the Arduino's regulator.

#### Problem Formulation

- How to design an affordable and reliable 4-DOF robotic arm that provides smooth, simultaneous control of multiple servos without stressing the Arduino's power subsystem?
- How to use off-the-shelf components (robot arm kit, Arduino UNO, PCA9685 driver, and servos) to build a reproducible system suitable for educational demonstrations and simple automation?

#### Proposed solution (brief)

- Use a 4-DOF mechanical arm kit for accurate mechanical assembly, four compatible servo motors for joints, an Arduino UNO as the controller, and a PCA9685 I<sup>2</sup>C PWM driver to generate servo PWM signals while powering servos from a separate 5V supply. User inputs (preprogrammed sequences) are read by the Arduino which instructs the PCA9685 to move servos.

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- 3. Objective of the Project:** (*Objectives should be mentioned pointwise. Students can also divide the broader and narrow areas of the objectives. These objectives must be near to the situation of the problems*)

### Broad Objectives

- a. Build a low-cost, stable, and reproducible 4-DOF robotic arm using widely available hardware.
- b. Demonstrate reliable multi-servo control using Arduino + PCA9685 for improved power and signal management.
- c. Provide an educational platform for learning embedded control, kinematics basics, and I<sup>2</sup>C peripheral integration.

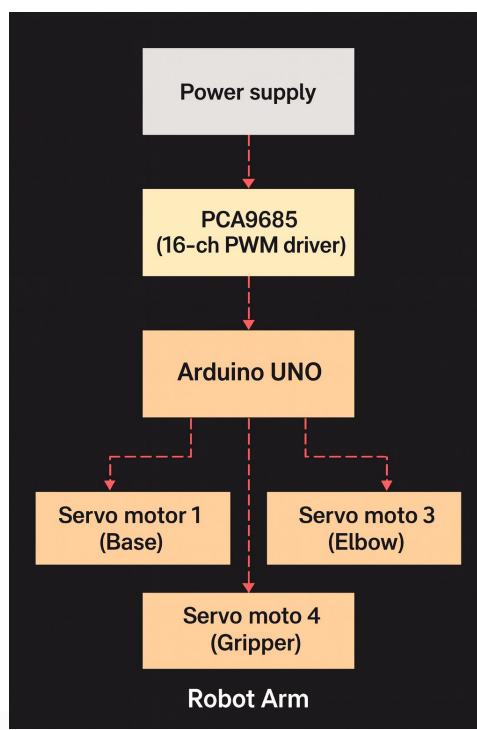
### Specific Objectives

- a. Assemble the mechanical robot arm kit and mount four servo motors (base, shoulder, elbow, gripper).
- b. Interface the PCA9685 PWM driver with Arduino UNO over I<sup>2</sup>C and power servos from an external 5V supply.
- c. Implement Arduino firmware to execute preprogrammed motion sequences and send PWM commands to PCA9685 channels.
- d. Implement preprogrammed motion sequences for common tasks (pick-and-place, wave, home position).
- e. Evaluate motion accuracy, response time, and power stability; document limitations and potential improvements.
- f. Produce a final demonstration and the project report including block and circuit diagrams, parts list, and code.

### Use Cases:

- o Demonstrate pick-and-place of small objects using preprogrammed motion.
- o Show a waving gesture by rotating the base servo back and forth.
- o Run a motion routine (like a “dance”) using synchronized servo movements.
- o Perform a grip test by opening and closing the gripper on different items.
- o Cycle through home and target positions to show repeatability and control.

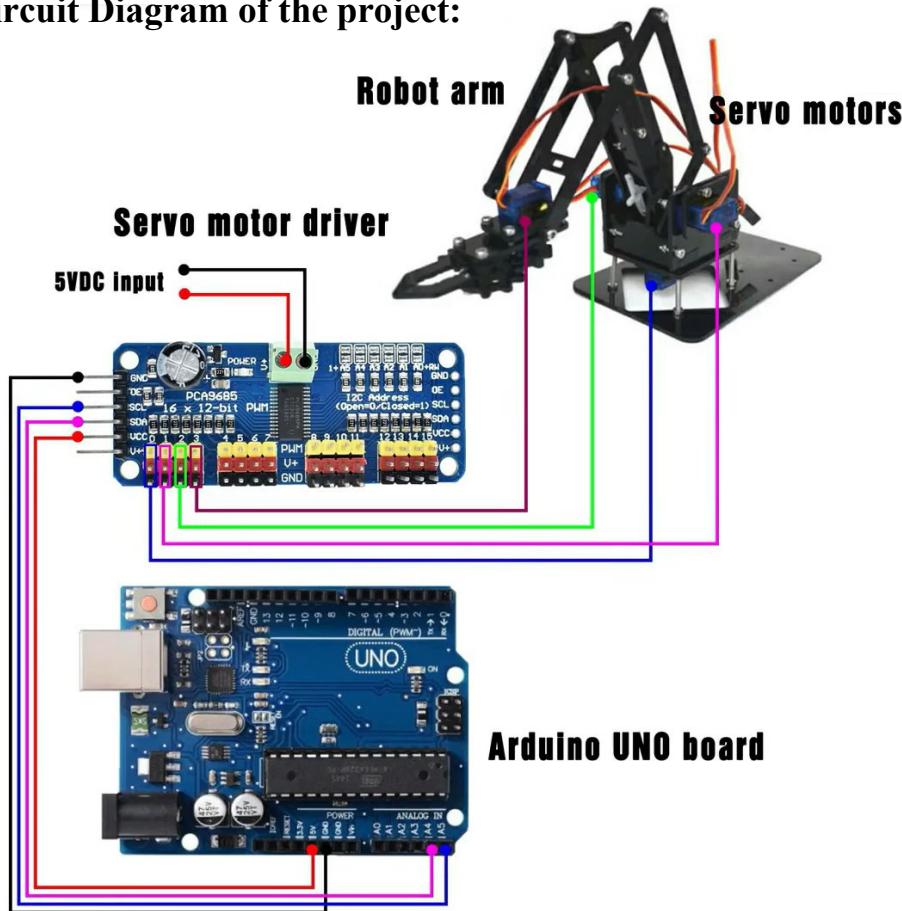
- 4. Block Diagram of the Project:** (*Diagram of a system in which the principal parts or functions are represented by blocks connected by lines that show the relationships of the blocks*)



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### 5. Circuit Diagram of the project:



### 6. Components/Items Required:

Sl. No.	Name of the Components	Specification	Quantity
1	Arduino UNO Board	ATmega328P, 16 MHz	1
2	Servo Motor	9g Micro Servo SG90 or MG995)	4
3	PWM Servo Motor Driver	PCA9685, 16-channel, I2C based	1
4	Robot Arm Kit	4-DOF acrylic/aluminum mechanical arm	1
5	Jumper Wires	Male-to-Male, Male-to-Female	As required
6	External Power Supply	5V DC, 2A adapter	1
7	USB Cable	For Arduino connection	1

Full Signature of Group members:

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

Signature of Corresponding Faculty