**Lesson Planning Template** **Teacher: DeSIRE**

| 📆Date: | Topic: Bus Servo Learning | Time Required: 120 minutes |
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🎯**Learning Target/Objectives:**

- I can install the required software to run the xArm robot.
- I can control the functions of the xArm robot.

| 📜**Vocabulary:** | ❓**Guiding Questions:** |
|---|---|
| • Serial Bus Servo.<br>• Asynchronous Serial Bus<br>• Closed-Loop Control<br>• Potentiometer<br>• Baud Rate<br>• Torque<br>• Neutral Position (Middle Position): | • **System Efficiency:** How does the "serial bus" communication mode simplify the physical wiring of a 6-axis robot arm compared to traditional PWM servos that require individual ports for every motor?<br>• **Feedback & Durability:** The document mentions that the built-in potentiometer provides feedback on temperature and voltage. How can a programmer use this data to increase the "service life" of the robot?<br>• **Physical Constraints:** If Servo ID 6 (the bottom motor) has a rotation limit of 320 degrees while others are limited to 240 degrees, how must the software's safety limits be adjusted to prevent mechanical failure?<br>• **Hardware Logic:** Why is it critical to set the servo to its "neutral position" before mechanical assembly, and what might happen if a potentiometer enters a "blind zone"? |

📚**Lesson Design Details:**

- **Activity 1: Activity 1: The "Chain of Command" Wiring Challenge**
    - **Objective:** Understand the difference between traditional wiring and serial bus communication.
    - **The Task:** Students are given a diagram of a traditional PWM servo setup (where every motor has its own wire back to the controller) and the xArm 1S "daisy-chain" setup.

- **Activity 2:** Ask students to map out the wiring for all 6 servos. They must explain how Servo ID 1 (the gripper) receives a command even though it is at the end of the physical chain.
    - **Discussion:** Discuss the benefit of "reducing the occupation of the serial port".

- **Activity 3: The "Neutral Zone" Calibration Lab**
    - **Objective:** Explore the importance of the "middle position" and potentiometers in closed-loop systems.
    - **The Task:** Before "assembling" a virtual or physical arm, students must simulate the "Initial Zero Point"[6].
    - **Activity:** Using a protractor, students must identify the middle point for a 240-degree rotation (LX-15D) versus a 320-degree rotation (Bottom Servo ID 6).
    - **Critical Thinking:** Have students write a "Warning Label" for a junior engineer explaining what happens when a potentiometer enters the "blind zone"[8].
- **Activity 3: The "Robot Health" Dashboard (Data Literacy)**
    - **Objective:** Interpret real-time data feedback from the hardware[99].
    - **The Task:** Using the "Servo Parameters" table, students act as "System Monitors"[10].
    - **Activity:** Provide students with a scenario: "Servo ID 3 is operating at 8.5V and the temperature is rising. Students must use the technical specs to determine if the servo is in danger (comparing it to the 6-8.4V operating range)[12].
    - **Math Integration:** Students calculate the torque difference when the arm moves from 6V to 7.4V (15kg.cm} vs 17kg.cm).

**Key Points (Vocabulary):**

- **Serial Bus Servo:** A type of digital servo that communicates via an asynchronous serial bus mode, allowing multiple units to be daisy-chained (connected in series).
- **Asynchronous Serial Bus:** A communication method where data is sent in command packets without a shared clock signal.
- **Closed-Loop Control:** A system that uses feedback (position, temperature, voltage) to ensure the output matches the desired command.
- **Potentiometer:** A built-in high-precision component that measures rotation and provides feedback on the servo's position.
- **Baud Rate:** The speed of communication between the controller and the servo, specified here as 115,200.
- **Torque:** The rotational force generated by the servo, measured in kg.cm (e.g., 25kg.cm for the LX-225).
- **Neutral Position (Middle Position):** The initial zero point for positive and negative rotation,

essential for avoiding "blind zones" during assembly.

| Feature | LX-15D (IDs 1-4, 6) | LX-225 (ID 5 - Body) |
|---|---|---|
| • **Max Torque** | 17 kg.cm @ 7.4V | **25 kg.cm** @ 7.4V |
| • **Rotation Range** | 0 degree - 240 degrees (standard) | 0 degrees - 240 degrees |
| **Bottom Pivot** | **320 degrees** (ID 6 special limit) | N/A |
| **Baud Rate** | 115,200 | 115,200 |
| **Operating Voltage** | 6.0V – 8.4V | 6.0V – 8.4V |
| **Connector Type** | PH2.0-3P | PH2.0-3P |
| **Feedback Data** | Temp, Voltage, Position | Temp, Voltage, Position |

📝**Materials/Resources:**

- Digital Journal (Google Slides  RECOMMENDED):

📋**Closing (Check for Understanding):**

- Discussion Review - students will share
  - Answers to Guiding Questions
  - Any surprises they experienced

| Category | Standard Organization | Standard/Benchmark Code & Description |
|---|---|---|
| **Computer Science** | **NCSOS (Level 1)** | **HS-CS-03:** Illustrate the ways computing systems implement logic, input, and output through hardware components. |
| **Computer Science** | **NCSOS (Level 1)** | **HS-AP-08:** Create computational artifacts with pre-existing procedures, external components, libraries and APIs. |
| **Technology & Engineering** | **ITEEA (STEL)** | **STEL-2P:** Select and use appropriate tools and skills to help do work and achieve a desired outcome (Grades 9-12). |

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| **Digital Literacy** | **ISTE** | **1.5.d:** Computational Thinker - Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions. |
| **Mathematics** | **NCSOS (NC Math 3/4)** | **NC.M3.F-TF.1:** Understand radian measure and its relationship to degree measure; specifically relevant to the 240-degrees and 320-degree limit angles mentioned. |