Lesson Planning Template **Teacher: DeSIRE**

📆Date:	Topic: Bus Servo Communication Protocol	Time Required: 90 minutes

🎯Learning Target/Objectives:

- **I can** identify the specific components of a serial command packet, including the header, ID, and checksum .
- **I can** explain the difference between a write command and a read command in a half-duplex communication system .
- **I can** calculate a checksum to ensure data integrity during robotic data transmission .

📜Vocabulary:

- **Asynchronous Serial Bus:**
- **Half-Duplex UART**
- **Baud Rate**
- **Checksum**
- **Broadcast ID**
- **Position Control Mode**
- **Motor Control Mode**

❓Guiding Questions:

- Why is a "Header" (0x55 0x55) necessary at the beginning of every data packet?
- How does the use of a "Broadcast ID" save time when initializing a robot with many joints, and what is its main limitation?
- In a "Half-Duplex" system, why must the PC software immediately switch to a "read condition" after sending a request for data?
- How does the "Checksum" act as a security guard for the robot's instructions?

📚Lesson Design Details:

- **Activity 1:** The Packet Architect
  - Focus: Students are given a robotic task (e.g., "Move Servo 5 to 90 degrees"). They must manually write out the hexadecimal string for the command packet, including the header and calculated checksum.
- **Activity 2:** Checksum Challenge
  - Focus: Students act as the "Servo Controller." The teacher provides several data packets, some with intentional errors in the checksum. Students must calculate the checksum and "reject" the corrupted packets.
- **Activity 3:** Fault Detective
  - Focus: Students are given a "Read status" return value (0-7). Using the LED error table, they must diagnose exactly what is wrong with the robot (e.g., "Over temperature and stalled").

Key Points (Vocabulary):

- **Asynchronous Serial Bus:** A communication method where up to 253 servos can be daisy-chained and controlled through a single interface.
- **Half-Duplex UART:** A communication protocol where data can be sent and received, but not at the same time, requiring precise timing control.
- **Baud Rate:** The speed of communication, set here at 115,200 bits per second (bps).
- **Checksum:** A value calculated from the data packet used to detect errors that may have occurred during transmission.
- **Broadcast ID:** A special ID number (254 or 0xFE) used to send a single command to every servo on the bus simultaneously .
- **Position Control Mode:** A setting where the servo moves to a specific angle between 0 and 240 degrees with high precision.
- **Motor Control Mode:** A setting where the servo acts as a speed-adjustable DC motor for continuous rotation .

Key Points of Instruction

- **Chain of Command:** Up to 253 servos can be connected in a chain, but each must have a unique ID (0-253) to avoid communication "conflicts".
- **Packet Anatomy:** Every command is a "packet." Students must understand the exact order: Header -> ID -> Length -> Command -> Parameter -> Checksum .
- **Precision and Speed:** Position mode allows for 0.24-degree increments, making it highly precise for delicate tasks.
- **Safety Protections:** The protocol includes built-in limits for temperature and voltage. If a servo exceeds 85 degrees Celsius, it will automatically enter an "unloaded" state to prevent permanent damage .

Teacher's Cheat Sheet

Feature	Key Technical Data
Baud Rate	115,200 bps
Servo Range	0 to 240 degrees
Precision	0.24 degree per increment

Voltage Range	6.0V to 7.4V (supports up to 12V limits)
Max Temperature	85 degrees Celsius (Default Limit)
Broadcast ID	254 (0xFE)
Packet Header	0x55 0x55
Checksum Logic	cksum = Bitwise NOT of (ID+Length+Cmd+Params)

Category	Standard Organization	Standard/Benchmark Code and Description
Computer Science	NCSOS	**HS-CS-03:** Illustrate the ways computing systems implement logic, input, and output through hardware components
Computer Science	NCSOS	**HS-NI-02:** Explain the protocols used to move data across a network (serial bus communication)
Technology	ITEEA	**STEL-2P:** Select and use appropriate tools and skills to help do work and achieve a desired outcome
Engineering	ITEEA	**STEL-2V:** Analyze the stability of a technological system and how it is influenced by components in the feedback loop[444].
Digital Literacy	ISTE	**1.5.d:** Students understand how automation works and use algorithmic thinking to develop a sequence of steps