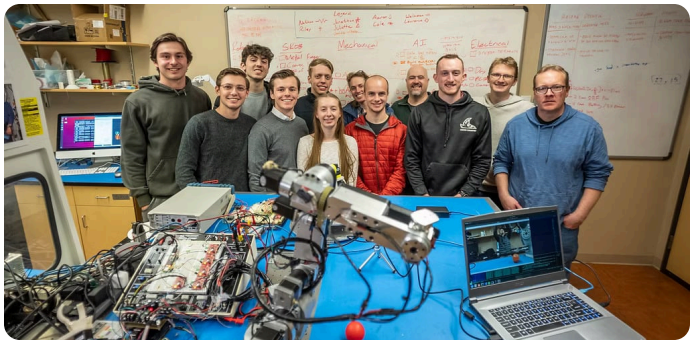
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AR4 for your classroom

The AR4 is a professional 6-axis robot arm that brings industrial automation to classrooms, labs, and workshops. Students build it, wire it, and program it with open-source software (Python and ROS). It has a 4.15 lb payload and 0.25 mm repeatability.





What students learn

- CAD and 3D printing: design and print custom grippers and tools
- Electronics: wiring, soldering, harnesses, and multimeter checks
- Programming: Python, ROS, G-code, C++ Arduino, Modbus/TCP for PLCs
- Kinematics, motion planning, and troubleshooting
- Vision systems with OpenCV
- Documentation, teamwork, and safety for human-robot work
- Skills that carry over to industrial robots (Fanuc, UR, ABB)

What the AR4 kit includes

- 26 machined aluminum pieces
- All bearings, belts, pulleys, shafts, pins, machine screws and set screws
- All the primary electrical components needed to build the robot

Stepper motors and drivers, and the gripper or tool holder, are separate options. See the AR4 kit page for the full list.

Free course and class tools

- An online AR4 build course made from the official build manual, with lessons students mark done and a certificate when they finish
- Professor dashboard: create a class with a join code and assign a course
- See each student's progress, who is stuck or inactive, set due dates, and download the class list
- Build your own course, or copy the build manual course

Sample curriculum

See what a real AR4 course covers and use it in your own class: anninrobotics.com/downloads/AR4_Robot_Curriculum_Enhanced.pdf

Free software and resources

- No proprietary software or licenses required
- Build manual, tutorials, knowledge base and community

Ordering for a school

Request a pro forma quote, or pay by invoice for your lab order, at anninrobotics.com/invoice. Questions? Email info@anninrobotics.com.

AR4 Robot in the Classroom

A Multi-Disciplinary, Project-Based Learning Platform

Mechanical Engineering	Electrical Engineering	Manufacturing / 3D Printing	Programming (C++ & Python)

Suitable For:

- High School STEM / CTE
- Community College Mechatronics
- University Engineering
- Capstone / Senior Design

Suggested Course Structure (Modular)

MODULE 1 | MECHANICAL DESIGN & ASSEMBLY

TOPICS COVERED

- Technical drawings & BOMs
- Mechanical assembly processes
- Bearings, tolerances & fits
- Fasteners, torque & alignment
- Gear reduction & motion transmission

HANDS-ON ACTIVITIES

- Assemble AR4 robot structure
- Identify & install components
- Analyze joint construction & load paths

LEARNING OUTCOMES

- Interpret mechanical documentation
- Understand real-world assembly
- Develop hands-on mechanical skills

MODULE 2 | ELECTRICAL SYSTEMS & WIRING

TOPICS COVERED

- Wiring diagrams & schematics
- Stepper motors & drivers
- Power distribution & grounding
- Signal vs power wiring
- Basic troubleshooting

HANDS-ON ACTIVITIES

- Wire motors, drivers & control boards
- Validate connections & continuity
- Diagnose wiring issues

LEARNING OUTCOMES

- Read & implement electrical schematics
- Understand motor control fundamentals
- Apply safe wiring practices

MODULE 3 | ELECTRONICS & EMBEDDED SYSTEMS

TOPICS COVERED

- Arduino / microcontroller fundamentals
- Digital I/O, PWM, serial communication
- Sensors & feedback systems
- C++ programming for control

HANDS-ON ACTIVITIES

- Commission the robot control system
- Upload & modify firmware
- Control outputs & read inputs

LEARNING OUTCOMES

- Understand embedded control systems
- Modify & deploy firmware
- Interface hardware with software

MODULE 4 | ADDITIVE MANUFACTURING (3D PRINTING)

TOPICS COVERED

- 3D printing technologies (FDM)
- Materials: PLA, PETG, CF blends
- Print settings & optimization
- Design for additive manufacturing

HANDS-ON ACTIVITIES

- Print AR4 components (covers, spacers)
- Adjust slicer settings
- Evaluate print quality & strength

LEARNING OUTCOMES

- Operate & optimize 3D printers
- Understand manufacturing constraints
- Connect design to production

MODULE 5 | ROBOT OPERATION & PROGRAMMING

TOPICS COVERED

- Robot coordinate systems (Joint vs Cartesian)
- Motion types (Joint, Linear, Circular)
- Basic automation workflows
- Teach points & pathing
- Robot programming basics

HANDS-ON ACTIVITIES

- Use AR4 HMI software to control robot
- Create pick-and-place routines
- Define waypoints & sequences

LEARNING OUTCOMES

- Understand robot motion fundamentals
- Program basic robotic tasks
- Gain familiarity with industrial concepts

- *Video Resources: Robot Programming Basics & Move Configuration tutorials available*

MODULE 6 | PYTHON SOFTWARE & HMI DEVELOPMENT

TOPICS COVERED

- Python fundamentals
- GUI development (Tkinter-based HMI)
- Serial communication with hardware
- Extending software functionality

HANDS-ON ACTIVITIES

- Modify AR4 HMI interface
- Add custom buttons or features
- Develop automation scripts

LEARNING OUTCOMES

- Understand software-to-hardware integration
- Build & modify user interfaces
- Apply programming to real systems

MODULE 7 | ROBOTICS THEORY (ADVANCED)

TOPICS COVERED

- Forward kinematics
- Inverse kinematics
- Transformation matrices
- Coordinate frames (DH parameters)
- Workspace & singularities

HANDS-ON ACTIVITIES

- Analyze robot motion mathematically
- Compare theoretical vs actual positions
- Use provided tutorials & examples

LEARNING OUTCOMES

- Understand how 6-axis robots calculate motion
- Apply mathematical models to hardware
- Bridge theory with physical systems

MODULE 8 | SIMULATION & DIGITAL TWINS

TOPICS COVERED

- Offline programming
- Robot simulation environments
- Digital twin concepts
- Industry tools

HANDS-ON ACTIVITIES

- Simulate robot programs
- Validate paths before execution
- Compare simulation vs real-world performance

LEARNING OUTCOMES

- Understand modern industrial workflows
- Use simulation for validation & planning
- Gain exposure to industry-standard tools

■ *Tools: ABB RobotStudio (free education version) · RoboDK*

MODULE 9 | SYSTEMS INTEGRATION (CAPSTONE)

TOPICS COVERED

- End-of-arm tooling (grippers, etc.)
- Sensors & I/O integration
- Process automation
- System troubleshooting

HANDS-ON ACTIVITIES

- Build a complete automated task (pick/place, sorting)
- Integrate external devices
- Debug full system operation

LEARNING OUTCOMES

- Integrate mechanical, electrical & software systems
- Develop real-world automation solutions
- Work in team-based engineering environments

TEACHING APPROACH & REAL CLASSROOM EXAMPLE

Rotating Team Structure

■■ **Mechanical / Assembly Team**	Focuses on structural assembly, joints, and load paths.
■■ **3D Printing / Manufacturing Team**	Handles printing components, optimizing settings.
■ **Programming / Simulation Team**	Manages firmware, HMI, and simulation environments.

■ **8–12 Week Program**	Lecture (theory) · Lab (hands-on) · Simulation (digital tools)

Real Classroom Example

✓ Uses *Industrial Robotics Fundamentals* (Ross/Fardo/Walach, 4th Edition)

✓ Builds multiple AR4 robots per class

✓ Strong emphasis on kinematics theory

✓ Uses RobotStudio and RoboDK for simulation

✓ Team-based rotating lab structure across a full academic quarter (~3 months)

✓ Integrates with Canvas LMS for assignment tracking, lab docs & video-based instruction

WHY THE AR4 WORKS WELL IN EDUCATION

Fully Visible System	Not a 'black box' — students can see and understand every component.
Open-Source Software	Built on Python and C++, freely modifiable and extensible.
Real Industrial Concepts	Professional-grade robotics skills at a fraction of the cost.
Hands-On From Day One	Immediate, tangible engagement with hardware and software.
Scalable Curriculum	Supports both beginner and advanced topics in the same platform.

Theory + Application	Bridges classroom learning with real-world engineering practice.

Additional Opportunities

→ Capstone engineering projects

→ Research platforms (ROS2, AI integration, vision systems)

→ PLC integration (Allen-Bradley, etc.)

→ Vision systems and AI-based pick-and-place

→ Remote labs / virtual simulation environments

ROS2 Tutorial available at: youtu.be/9jmXEHAL-Vk