Robotics and Automated Systems - UAS

Level: 3
Career Cluster: Advanced Manufacturing
Program: Engineering
Pathway(s): Engineering Applications UAS, Engineering

Course Catalog Description

Students explore robotics, automation, and drone systems as they learn how technologies are designed, programmed, tested, and applied to solve real-world problems. The course emphasizes engineering practices, system components, safety, ethics, and technical communication through hands-on design and analysis.

Summary

Applied engineering course in which students explore how robotics, automation, and drone technologies are designed, programmed, tested, and used to solve real-world problems. Through career exploration, students examine industry pathways, postsecondary opportunities, professionalism, and the legal and ethical responsibilities associated with these fields. Students study the evolution of robotics and automation, analyze how sensors, electronics, control systems, and mechanical components work together, and develop programming logic for robotic and autonomous functions. They apply concepts such as feedback loops, motion, power transmission, safety, maintenance, and system performance evaluation while collecting and interpreting data to improve reliability and efficiency. By the end of the course, students design, test, document, and present a robotic or drone-based solution using technical vocabulary, engineering practices, and responsible decision-making.

Notes

Compared with the older course, this revised version expands the scope beyond traditional robotics to include automation and drone systems, creating a more current and industry-relevant focus. The updated course is organized into clearer, more comprehensive learning strands that strengthen safety, ethics, programming, sensors, electronics, feedback systems, mechanics, testing, and applied design, while also adding dedicated sections for leadership, work-based learning, and CTSO integration. Overall, the revision places greater emphasis on career exploration, technical communication, real-world problem solving, and connections to emerging technologies and postsecondary pathways.

Student Learning Outcomes

1. Career Exploration and Postsecondary Opportunities

Objective: *Students will analyze career pathways in engineering and drones by exploring industry roles, workplace expectations, required education, certifications, professional organizations, and postsecondary opportunities available in Colorado in order to make informed academic and career decisions.*

1) Identify employment opportunities in various fields with a focus in the area of engineering and drones
    a. Recognize the work typically performed, tools and technology used, and nature of work environments
    b. Identify potential certifications within the careers
    c. Find membership organizations associated with the careers
    d. Understand the necessary education associated within the careers
2) Define professionalism within the context of engineering and drones
    a. Criticism and evaluation
    b. Presentation
    c. Assessment
3) Recognize laws, regulations, and ethics significant to the fields of engineering and drones
4) Identify postsecondary opportunities offered in the state of Colorado
    a. Technical college, community college, 4-year institutions
    b. Certificates, associates, bachelor, and advanced degree opportunities

2. Robotics Foundations and the Evolution of Automation

Objective: *Students will explain the historical development and modern uses of robotics and automation and connect these concepts to drone systems.*

5) Summarize the historical development of robotics and automated systems
6) Explain why robots are used in specific environments and industries
7) Compare automated systems used in advanced manufacturing, medicine, agriculture, aerospace, and drone technology
8) Analyze the benefits and limitations of robotic systems in real-world applications
9) Interpret how automation improves efficiency, safety, precision, and repeatability
10) Relate the evolution of robotics to autonomous drone technologies and intelligent flight systems

3. Ethical Innovation, Safety, and Responsible System Design

Objective: *Students will evaluate ethical, legal, and safety considerations related to robotics, automation, and drone systems.*

11) Interpret classroom and lab safety rules for robotics and automated system work
12) Explain the purpose of safety equipment and safe operating procedures
13) Analyze ethical issues involved in producing and using automated technologies
14) Evaluate how privacy, surveillance, bias, safety, and reliability affect acceptance of automated systems

15) Defend responsible decisions related to robotics and drone use in society
16) Apply safe procedures when building, testing, and maintaining robotic and drone systems

4. Programming Logic and Robotic Control

Objective: *Students will develop programs that control robotic and drone-related systems using structured programming processes.*

17) Define the stages of a robotic system programming cycle
18) Construct a flowchart for a robotic or drone automation task
19) Convert a flowchart into a working program
20) Test and modify code to improve performance and reliability
21) Optimize program behavior for efficiency and precision
22) Write a technical explanation evaluating the performance of a robotic or drone control program
23) Develop basic logic for autonomous drone actions such as takeoff sequences, waypoint routines, return-to-home logic, or obstacle responses

5. Sensors, Inputs, Outputs, and Data Systems

Objective: *Students will analyze how sensors and input/output systems allow robotic and drone platforms to interact with their environments.*

24) Identify common input and output devices used in robotic systems
25) Explain how sensors provide information to an automated system
26) Log, store, and export data from two or more sensors
27) Interpret why sensor data collection is useful for testing, optimization, and mission analysis
28) Compare sensor roles in robots and drones, including distance, light, motion, GPS, altitude, temperature, and camera-based sensing
29) Analyze how drone sensors support stabilization, navigation, mapping, and autonomous decision-making
30) Evaluate data quality and reliability from robotic or drone subsystems

6. Computers, Electronics, and Drone System Architecture

Objective: *Students will examine the electronic and computing components that make robotic and drone systems function as integrated platforms.*

31) Describe the parts needed to make a robot and distinguish it from a standard computer or a non-robotic machine
32) Identify major system components such as microprocessors, sensors, controls, motors, and communication modules
33) Explain how electronic components support system input, processing, and output
34) Compare the architecture of robotic systems and drone flight systems
35) Analyze how controllers, processors, and power systems support drone functionality
36) Design a simple system diagram that shows how a drone or robotic platform processes information and responds to commands

7. Feedback Loops, Autonomy, and Intelligent Behavior

Objective: *Students will apply feedback-control principles to understand how robots and drones monitor conditions and adjust behavior automatically.*

37) Explain the purpose of a feedback loop in a robotic system
38) Analyze how feedback improves control, stability, and performance
39) Compare open-loop and closed-loop systems
40) Interpret how drones use feedback from onboard sensors to maintain altitude, heading, and position
41) Evaluate how feedback systems support safe autonomous flight and robotic movement
42) Develop an example of a closed-loop control process for a drone or robotic subsystem

8. Mechanics, Motion, and Power Transmission

Objective: *Students will analyze the mechanical principles that influence robotic motion and apply those concepts to drone and automated system design.*

43) Use mechanical tools and systems such as motors, gears, and gear trains in robotic or automated designs
44) Identify where forces act at different points in a system
45) Explain the relationships among force, torque, work, and power
46) Develop a system that demonstrates how these principles affect a robotic or drone subsystem
47) Compare mechanical motion in ground robotics with rotor-driven or actuator-based motion in drones
48) Evaluate how mechanical design influences efficiency, payload, movement, and control

9. Testing, Maintenance, Documentation, and Quality Assurance

Objective: *Students will evaluate robotic and drone system performance through testing, maintenance, measurement, and technical documentation.*

49) Use appropriate instruments to measure electrical, light, audio, or other outputs of a robotic system
50) Compare measured performance data to acceptable norms
51) Document whether a system operates within expected parameters
52) Perform maintenance or follow procedures to correct malfunctions or underperformance
53) Create a service and maintenance report on a robotic or automated system
54) Apply testing and documentation practices to drone systems, including propulsive, sensor, and controller performance
55) Recommend improvements based on testing evidence and observed performance issues

10. Applied Drone Robotics and Automated Mission Design Project

Objective: *Students will design and evaluate a drone-related robotic or automated system that solves a real-world problem.*

56) Define a real-world problem that can be addressed through robotics or drone automation
57) Develop a design concept using appropriate sensors, controls, and mechanical components
58) Construct a basic mission workflow or control logic for the system

59) Test the system or simulation and collect performance data
60) Analyze results to determine whether the design meets criteria and constraints
61) Present the completed system or concept using engineering and robotics vocabulary

11. Leadership

Objective: *Students will demonstrate leadership skills by communicating effectively, collaborating with others, taking initiative, and contributing responsibly to team and project goals in robotics, automation, and drone-related contexts.*

62) Demonstrate effective communication skills in team-based robotics, automation, or drone projects
63) Apply collaboration, problem-solving, and conflict-resolution strategies during shared tasks
64) Exhibit initiative, responsibility, and adaptability when completing technical assignments and project roles
65) Practice professional behaviors such as time management, accountability, dependability, and ethical decision-making
66) Evaluate personal leadership growth and contributions to class, lab, CTSO, or project-based experiences

12. Work-Based Learning

Objective: *Students will connect classroom learning to career applications through work-based learning experiences, career exploration activities, and interactions with industry professionals related to robotics, automation, and drone technologies.*

67) Identify the purpose and value of work-based learning experiences in career and technical education
68) Participate in career exploration activities such as guest speakers, job shadows, site visits, industry projects, or internships when available
69) Demonstrate workplace expectations including professionalism, communication, safety, and appropriate conduct in real work settings
70) Apply technical knowledge and employability skills in experiences connected to robotics, automation, engineering, or drone-related careers
71) Reflect on work-based learning experiences to evaluate career interests, workplace skills, and postsecondary goals

13. Career and Technical Student Organizations

Objective: *Using the CTSO Resource Document, chapter activities will provide some of the best opportunities CTSO members will have to learn by doing. A successful program of work creates a positive learning atmosphere in the classroom. CTSO members learn how to accept responsibility, work as a team, manage a budget, and handle success and failure. Per the CTE Admin Handbook, CTSOs are embedded into curriculum.*

Professional Development

Prepare each member for entry into the workforce and provide a foundation for success in a career. Becoming a professional does not stop with acquiring a skill, but involves an increased awareness of the meaning of good citizenship and the importance of labor and management in the world of work.

Community Service

Promote and improve goodwill and understanding among all segments of the community through services donated by CTSO chapters, and to instill in its members a lifetime commitment to community service.

Business and Industry Connections

Increase awareness of quality job practices and attitudes, and increase the opportunities for employer engagement and eventual employment.

Financial Leadership

Plan and participate in activities to allow all members to carry out the chapter's projects. Educate members on their own personal finance for current and future success.

Public Relations

Make the general public aware of the good work that students in career and technical education are doing to better themselves and their community, state, nation, and world.

Social Activities

To increase cooperation in the school and community through activities that allow CTSO members to get to know each other in something other than a business or classroom setting.

Academic Standards Alignment

Colorado CTE courses are required to integrate academic and essential skills into course content. The following academic standards have been identified as aligned to this course and should be integrated throughout instruction.

CO CTE Academic Standards Resources (Rubrics, integration strategies, etc)
CDE Colorado Academic Standards Online (Online standards lookup tool)

Note: Mathematics and Science standards will be added in the future. Visit the Colorado Academic Standards page for the most current version.

Reading, Writing and Communicating Crosswalk

Course: Robotics and Automated Systems
Colorado Academic Standards – Reading, Writing, and Communicating

Standard	Prepared Graduate Competency	Description	Course Evidence / Alignment
Standard 1: Oral Expression and Listening	Prepared Graduate 1 – Collaboration	Collaborate effectively as group members or leaders who listen actively and respectfully.	Students work in teams to design, program, test, and maintain robotic systems; collaborate during troubleshooting and optimization; and contribute ideas.
Standard 1: Oral Expression and Listening	Prepared Graduate 2 – Oral Presentations	Deliver effective oral presentations for varied audiences and varied purposes.	Students explain robotic and automated system designs, communicate programming logic and performance results, and share findings orally with peers and instructors.
Standard 2: Reading for All Purposes	Prepared Graduate 4 – Informational Texts	Read a wide range of informational texts to build knowledge.	Students read and interpret technical manuals, datasheets, schematics, programming documentation, safety procedures,

			and career information related to robotics and automation.
Standard 2: Reading for All Purposes	Prepared Graduate 5 – Language in Context	Understand how language functions in different contexts.	Students use and interpret discipline-specific technical language such as sensors, actuators, feedback loops, control systems, and programming syntax.
Standard 3: Writing and Composition	Prepared Graduate 7 – Informational Writing	Craft informational/explanatory texts using techniques specific to the genre.	Students write technical reports evaluating robotic program performance and document system operation, testing results, and maintenance procedures.
Standard 3: Writing and Composition	Prepared Graduate 9 – Writing Process	Demonstrate mastery of their own writing process with clear, coherent, and error-free polished products.	Students draft, revise, and finalize technical documentation and produce polished reports and service or maintenance documentation for robotic systems.
Standard 4: Research Inquiry and Design	Prepared Graduate 10 – Research and Ethics	Gather information from a variety of sources; analyze and evaluate its quality and relevance; and use it ethically.	Students research historical and current uses of robotics, investigate ethical considerations of automated systems, and collect, analyze, and document sensor and system data to support conclusions.

Free Resource Links

1. Career Exploration and Postsecondary Opportunities

- Bureau of Labor Statistics Robotics Careers (robotics careers engineering jobs education pathways)
  https://www.bls.gov/ooh
- CareerOneStop Engineering Careers (career pathways certifications workforce skills robotics automation)
  https://www.careeronestop.org
- NASA STEM Careers (engineering robotics aerospace workforce skills opportunities)
  https://www.nasa.gov/stem
- FIRST Robotics Resources (robotics competitions careers STEM workforce development)
  https://www.firstinspires.org

2. Robotics Foundations and the Evolution of Automation

- NASA Robotics Overview (history robotics automation space exploration systems)
  https://www.nasa.gov/robotics
- IEEE Robotics and Automation Society (robotics history standards research applications)
  https://www.ieee-ras.org
- National Geographic Robotics (robotics history automation impact society industry)
  https://www.nationalgeographic.org
- Boston Dynamics Robotics Videos (robotics applications autonomous systems real world use)
  https://www.bostondynamics.com

3. Ethical Innovation, Safety, and Responsible System Design

- Common Sense Digital Citizenship (ethics technology safety privacy responsible use)
  https://www.commonsense.org/education
- IEEE Ethics in Engineering (engineering ethics robotics technology responsibility)
  https://www.ieee.org
- AI Ethics Guidelines European Commission (ethical design automation artificial intelligence safety)
  https://digital-strategy.ec.europa.eu
- CISA Cybersecurity Awareness (system safety risk mitigation secure operations)
  https://www.cisa.gov

4. Programming Logic and Robotic Control

- Code.org Programming Fundamentals (coding logic algorithms loops conditionals basics)
  https://code.org
- VEX Robotics Programming (robotics coding control systems autonomous programming)
  https://www.vexrobotics.com
- Arduino Programming Basics (microcontroller coding sensors actuator control)
  https://www.arduino.cc

- Scratch MIT Programming (intro coding logic simulation automation basics)
  https://scratch.mit.edu

5. Sensors, Inputs, Outputs, and Data Systems

- SparkFun Sensors Guide (sensors inputs outputs electronics data collection basics)
  https://learn.sparkfun.com
- Arduino Sensor Projects (sensor integration data collection robotics applications)
  https://projecthub.arduino.cc
- NASA Remote Sensing Basics (sensors data collection earth observation systems)
  https://earthobservatory.nasa.gov
- Adafruit Sensor Tutorials (input output systems microcontrollers sensor integration)
  https://learn.adafruit.com

6. Computers, Electronics, and Drone System Architecture

- Khan Academy Computer Systems (computers hardware software systems architecture basics)
  https://www.khanacademy.org
- HowStuffWorks Microprocessors (microprocessors computing architecture embedded systems)
  https://computer.howstuffworks.com
- Arduino Electronics Basics (circuits microcontrollers robotics embedded systems)
  https://www.arduino.cc
- Raspberry Pi Computing Projects (embedded systems programming robotics automation applications)
  https://www.raspberrypi.org

7. Feedback Loops, Autonomy, and Intelligent Behavior

- MIT Control Systems Basics (feedback loops control systems automation fundamentals)
  https://ocw.mit.edu
- NASA Control Systems Explanation (feedback control systems flight stability automation)
  https://www.grc.nasa.gov
- Khan Academy Systems and Control (feedback loops system response stability concepts)
  https://www.khanacademy.org
- VEX Robotics Autonomous Systems (autonomous control robotics behavior feedback systems)
  https://www.vexrobotics.com

8. Mechanics, Motion, and Power Transmission

- Khan Academy Work and Energy (force torque work power motion physics)
  https://www.khanacademy.org
- NASA Forces and Motion (forces motion engineering physics systems)
  https://www.grc.nasa.gov
- MIT Kinematics Basics (motion mechanics engineering systems movement)
  https://ocw.mit.edu

- Engineering Explained Mechanics (mechanical systems gears motors motion concepts)
  https://www.engineeringexplained.com

9. Testing, Maintenance, Documentation, and Quality Assurance

- IEEE Engineering Standards (testing standards quality assurance engineering systems)
  https://www.ieee.org
- ISO Quality Management Basics (quality assurance standards system testing processes)
  https://www.iso.org
- NASA Systems Engineering Handbook (testing validation verification engineering systems)
  https://www.nasa.gov
- Khan Academy Scientific Method (testing analysis data evaluation engineering processes)
  https://www.khanacademy.org

10. Applied Drone Robotics and Automated Mission Design

- DroneBlocks Mission Programming (drone missions coding automation waypoint planning)
  https://droneblocks.io
- DJI Education Resources (drone systems mission planning automation applications)
  https://edu.dji.com
- NASA Engineering Design Projects (engineering design problem solving robotics applications)
  https://www.nasa.gov/stem
- ESRI Drone Mapping Projects (drone applications mapping GIS data mission design)
  https://www.esri.com

11. Leadership

- Technology Student Association Leadership (leadership teamwork communication collaboration student organization skills)
  https://tsaweb.org/students/leadership
- Lead4Change High School Leadership Resources (leadership service learning communication problem solving teamwork)
  https://lead4change.org
- National Association of Student Councils Leadership Development (student leadership communication initiative civic engagement teamwork)
  https://www.natstuco.org/leadership-development/
- America Succeeds Communication Skills in Schools (communication presentation student voice career readiness collaboration)
  https://americasucceeds.org/finding-their-voice-how-schools-build-communication-skills

12. Work-Based Learning

- NAF Work-Based Learning (work-based learning internships career exploration industry partnerships student readiness)
  https://ash.naf.org/public/wbl

- Advance CTE Work-Based Learning Resources (experiential learning apprenticeships internships career pathways policy guidance)
  https://careertech.org/resource-center/topics/work-based-learning/
- Work-Based Learning Alliance (virtual work-based learning industry connected learning career readiness access)
  https://workbasedlearningalliance.org/
- Britebound High School Work-Based Learning Success (high school work-based learning internships apprenticeships career discovery)
  https://www.britebound.org/insights/making-it-work-report

Technology Student Association – National Competitive Events

Drone Challenge (UAV)

Objective: *Students will design, build, document, test, and present an open-source UAV drone that meets TSA Drone Challenge requirements for flight performance, safety, documentation, programming, and mission completion.*

- Research the annual TSA Drone Challenge specifications, mission requirements, and applicable drone-flight regulations.
- Design or modify an open-source UAV drone that meets TSA size, motor, propeller, guard, payload, camera, and mission-function requirements.
- Assemble and wire drone components, including motors, flight controllers, electronic speed controllers, cameras, antennas, and related systems.
- Document the UAV through a portfolio that includes a photo log, wiring schematics, programming explanation, engineered drawings, bill of materials, and work log.
- Program and configure the drone for flight functioning, stabilization, and mission-specific operation.
- Complete safety inspection, flight practice, drone testing, and mission performance procedures.
- Participate in an interview explaining the drone design, programming, components, safety decisions, and mission performance.

Resources

- Technology Student Association – Drone Challenge (UAV) competition guidelines
  https://tsaweb.org/competitions-programs/tsa/themes-problems
- Federal Aviation Administration – Drone safety and regulations
  https://www.faa.gov/uas
- ArduPilot Documentation – Open-source autopilot software
  https://ardupilot.org/
- PX4 Autopilot User Guide
  https://docs.px4.io/

Technology Student Association – National Competitive Events

Robotics

Objective: *Students will design, build, test, operate, document, and explain a robot that completes the annual TSA Robotics challenge within competition requirements.*

- Analyze the annual TSA Robotics challenge and identify required tasks, constraints, safety considerations, and scoring criteria.
- Design and construct a robot that integrates mechanical, electrical, control, and structural systems.
- Test robot performance before competition and make adjustments to improve reliability, control, and task completion.
- Operate the robot during the timed challenge while completing required tasks within the allotted window.
- Troubleshoot, repair, or adjust the robot during competition when needed while following event procedures.
- Document the robot's design, construction, testing, revisions, and team problem-solving process.
- Participate in a team interview explaining robot systems, design decisions, programming or control strategies, and performance results.

Resources

- Technology Student Association – Robotics competition guidelines
  https://tsaweb.org/competitions-programs/tsa/themes-problems
- VEX Robotics STEM Labs
  https://education.vex.com/
- Arduino Education – Robotics and electronics resources
  https://www.arduino.cc/education
- FIRST Robotics Resource Library
  https://www.firstinspires.org/resource-library

Technology Student Association – National Competitive Events

System Control Technology

Objective: *Students will design, construct, program, document, troubleshoot, and demonstrate a working control-system solution that responds to a TSA-provided problem.*

- Interpret the TSA-provided control-system problem and identify the required functions, constraints, and performance goals.
- Design a system that uses inputs, outputs, controls, sensors, motors, feedback, or programmable components to solve the assigned problem.
- Create a program or control sequence that allows the system to operate as intended.
- Construct and test the system using approved materials, tools, electronics, and safety procedures.
- Troubleshoot mechanical, electrical, sensor, programming, or feedback-loop issues to improve system performance.
- Maintain an inventor's log or documentation record describing design decisions, testing, revisions, and final operation.
- Demonstrate the completed system and explain how the design meets the problem criteria during judge evaluation.

Resources

- Technology Student Association – System Control Technology competition guidelines https://tsaweb.org/competitions-programs/tsa/themes-problems
- Arduino Education – Electronics and control systems https://www.arduino.cc/education
- VEX Robotics STEM Labs – Mechanisms, sensors, and programming https://education.vex.com/
- Tinkercad Circuits – Circuit simulation and prototyping https://www.tinkercad.com/circuits