

Principles of Flight - UAS

Level: 3

Career Cluster: Advanced Manufacturing

Program: Engineering

Pathway(s): Engineering Applications UAS

Course Catalog Description

Introduces students to the principles of flight, including aerodynamics, aircraft and drone systems, navigation, weather, regulations, and safety. Students apply these concepts through flight planning, simulation, and mission-based drone operations.

Summary

Introduces students to the core concepts, systems, and procedures that shape safe and effective flight in both traditional aircraft and unmanned aircraft systems. Through the study of aerodynamic forces, aircraft and drone design, control systems, navigation, airspace, regulations, weather, and risk management, students develop the knowledge needed to analyze flight performance and make informed operational decisions. Students also examine how drones use sensors, software, telemetry, and autonomous flight features to complete missions across a range of industries such as agriculture, media, inspection, mapping, and public safety. The course emphasizes technical vocabulary, safe operating practices, legal and ethical responsibilities, teamwork, and professional communication as students interpret real-world aviation and drone scenarios. By the end of the course, students apply their learning through mission planning, simulation, performance analysis, and a capstone drone mission project that integrates principles of flight into practical, career-connected operations. In addition, the course supports career exploration, leadership development, and work-based learning connections to help students understand postsecondary pathways and workplace expectations in aviation, engineering, and drone-related fields.

Notes

This updated course revises the earlier document by shifting the emphasis from traditional piloted aircraft and preparation for advanced manned flight study to a broader, more current UAS-centered approach that reflects the growing role of drones in engineering and aviation pathways. While foundational flight concepts such as aerodynamics, control, navigation, airspace, weather, and safety remain central, the revised course adds stronger attention to drone systems, autonomy, mission planning, telemetry, and applied drone operations in real-world settings. The new version is also organized into clearer instructional sections with updated student learning outcomes that are more explicitly aligned to career readiness, technical application, and CTE course design expectations. Additional updates include dedicated sections for leadership and work-based learning, expanded emphasis on legal and ethical responsibilities, and a capstone-style drone mission project that gives students the opportunity to apply flight principles in a more practical, industry-relevant context.

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. Foundations of Flight and Aerodynamic Forces

Objective: *Students will explain the four forces of flight and apply them to both traditional aircraft and drone systems.*

- 5) Define lift, drag, thrust, and weight
- 6) Explain how these forces interact during flight
- 7) Compare aerodynamic forces acting on fixed-wing aircraft and drones
- 8) Analyze how changes in design affect flight performance
- 9) Interpret how control inputs impact force balance
- 10) Apply aerodynamic principles to drone flight scenarios

3. Aircraft and Drone Design and Performance

Objective: *Students will analyze how aircraft and drone design influences performance and flight behavior.*

- 11) Identify key components of aircraft and drones
- 12) Compare fixed-wing, rotary-wing, and multirotor systems
- 13) Explain how design elements affect lift, stability, and efficiency
- 14) Analyze factors such as weight, materials, and propulsion
- 15) Evaluate performance differences across drone platforms
- 16) Design a conceptual drone suited for a specific mission

4. Control Systems, Stability, and Maneuvering

Objective: Students will apply flight control principles to understand aircraft and drone maneuverability.

- 17) Explain pitch, roll, yaw, and throttle
- 18) Describe stability and control in flight systems
- 19) Analyze how drones maintain balance using sensors and software
- 20) Interpret how pilot or operator inputs affect movement
- 21) Compare manual and autonomous control systems
- 22) Evaluate stability challenges in drone operations

5. Navigation, Flight Planning, and Route Design

Objective: Students will analyze navigation methods and apply them to flight and drone mission planning.

- 23) Identify basic navigation concepts such as heading and position
- 24) Explain how GPS and navigation systems guide drones
- 25) Interpret maps, charts, and mission-planning tools
- 26) Develop a simple route plan using waypoints
- 27) Analyze navigation risks and limitations
- 28) Evaluate navigation decisions based on mission goals

6. Airspace, Regulations, and Legal Flight Operations

Objective: Students will interpret aviation regulations and apply them to drone operations.

- 29) Identify types of airspace and their restrictions
- 30) Explain FAA drone regulations and operational limits
- 31) Analyze how airspace impacts flight planning
- 32) Evaluate legal requirements for drone operations
- 33) Apply compliance rules to mission scenarios
- 34) Justify operational decisions based on regulations

7. Weather, Environment, and Flight Performance

Objective: Students will analyze environmental factors and evaluate their impact on flight operations.

- 35) Identify weather factors that impact flight
- 36) Explain how wind, temperature, and pressure affect performance
- 37) Analyze environmental challenges for drones
- 38) Interpret basic weather data for planning
- 39) Predict flight behavior under different conditions
- 40) Recommend safe operational adjustments

8. Safety, Risk Management, and Human Factors

Objective: Students will evaluate safety risks and apply risk management strategies to aviation and drone operations.

- 41) Identify common risks in flight operations
- 42) Explain human factors affecting decision-making
- 43) Analyze safety incidents and contributing causes
- 44) Evaluate risk mitigation strategies
- 45) Apply safety procedures to preflight and inflight scenarios
- 46) Defend decisions that prioritize operational safety

9. Drone Systems, Autonomy, and Flight Technology

Objective: *Students will analyze drone systems and apply knowledge of automation and control technologies.*

- 47) Explain how drones use sensors and software for control
- 48) Identify autonomous flight features such as waypoint navigation
- 49) Analyze how telemetry provides flight data
- 50) Compare automated flight with manual operation
- 51) Evaluate benefits and limitations of autonomous systems
- 52) Apply system knowledge to drone mission scenarios

10. Operational Procedures and Real World Applications

Objective: *Students will apply flight principles to real-world drone operations across industries.*

- 53) Describe drone use in agriculture, inspection, media, and safety
- 54) Analyze operational procedures across industries
- 55) Evaluate effectiveness of drone applications
- 56) Apply flight knowledge to mission scenarios
- 57) Compare different operational strategies
- 58) Recommend improvements to mission design

11. Flight Systems and Drone Mission Project

Objective: *Students will design, develop, and evaluate a drone mission that integrates principles of flight.*

- 59) Define a mission objective and constraints
- 60) Develop a flight plan including route and environmental considerations
- 61) Apply aerodynamic and operational principles
- 62) Analyze mission performance through testing or simulation
- 63) Present findings using technical language
- 64) Evaluate effectiveness and propose improvements

12. Leadership

Objective: *Students will develop leadership skills by applying communication, collaboration, responsibility, and ethical decision-making in aviation and drone-related contexts.*

- 65) Demonstrate leadership skills through teamwork, communication, and problem solving
- 66) Analyze the qualities of effective leaders in aviation, engineering, and drone operations

- 67) Apply ethical decision-making and accountability in team-based projects and flight scenarios
- 68) Demonstrate initiative and professionalism in classroom, lab, and field experiences
- 69) Evaluate personal leadership strengths and areas for growth through reflection and feedback

13. Work-Based Learning

Objective: *Students will connect classroom learning to workplace expectations by exploring, participating in, and reflecting on work-based learning experiences related to aviation and drone operations.*

- 70) Identify work-based learning opportunities related to aviation, engineering, and drone careers
- 71) Demonstrate workplace readiness skills such as punctuality, communication, collaboration, and responsibility
- 72) Apply technical knowledge and safety practices in authentic workplace settings
- 73) Analyze how workplace experiences reinforce course concepts and career goals
- 74) Reflect on work-based learning experiences to identify skills gained and next steps for career development

14. 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: Principles of Flight - UAS

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.	Students collaborate during flight scenarios and safety discussions, analyze procedures and operational decisions together, and respond to peer input when evaluating flight situations.
Standard 1: Oral Expression and Listening	Prepared Graduate 2 – Oral Presentations	Deliver effective oral presentations for varied audiences and varied purposes.	Students verbally explain flight principles, procedures, and safety considerations, communicate decision-making during simulations, and present findings related to aviation safety and operations.
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 aviation textbooks, manuals, FAA-aligned

			resources, technical descriptions of aircraft systems and flight procedures, and industry articles related to aviation safety and operations.
Standard 2: Reading for All Purposes	Prepared Graduate 5 – Language in Context	Understand how language functions in different contexts.	The course requires accurate use of aviation-specific terminology, understanding of regulatory, procedural, and technical language, and precise language choices appropriate to safety-critical contexts.
Standard 3: Writing and Composition	Prepared Graduate 6 – Craft arguments	Craft arguments using techniques specific to the genre.	Students justify flight and safety decisions using evidence and regulations, defend operational choices drawn from researched aviation practices, and support conclusions with data and authoritative aviation sources.
Standard 3: Writing and Composition	Prepared Graduate 7 – Informational Writing	Craft informational/explanatory texts using techniques specific to the genre.	Students produce written explanations of flight principles and safety procedures, technical reports on aviation safety enhancements, and explanatory summaries of flight scenarios.

Standard 3: Writing and Composition	Prepared Graduate 9 – Writing Process	Demonstrate mastery of their own writing process.	Students draft, revise, and finalize aviation reports and explanations, produce clear and polished technical writing, and apply correct aviation conventions in final products.
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.	Students gather information from print and digital aviation sources, research industry practices related to aviation safety, and analyze findings for ethical application to future decision-making.

Free Resource Links

1. Career Exploration and Postsecondary Opportunities

- Bureau of Labor Statistics Aviation Careers (aviation careers aerospace jobs education pathways workforce trends)
<https://www.bls.gov/ooh>
- FAA Aviation Careers (pilot aerospace certifications training pathways)
<https://www.faa.gov/jobs>
- CareerOneStop Engineering Careers (career pathways certifications aviation workforce skills)
<https://www.careeronestop.org>
- NASA STEM Careers (STEM aviation engineering technology workforce opportunities)
<https://www.nasa.gov/stem>

2. Foundations of Flight and Aerodynamic Forces

- NASA Beginner Guide to Aeronautics (lift drag thrust weight aerodynamics fundamentals)
<https://www.grc.nasa.gov>
- FAA Pilot Handbook of Aeronautical Knowledge (flight principles aerodynamics aircraft systems)
<https://www.faa.gov>
- MIT Aerodynamics Resources (airfoil forces fluid dynamics engineering concepts)
<https://web.mit.edu>
- Khan Academy Lift and Drag (forces flight physics aerodynamics concepts)
<https://www.khanacademy.org>

3. Aircraft and Drone Design and Performance

- NASA Aircraft Design Basics (aircraft structure aerodynamics performance design)
<https://www.grc.nasa.gov>
- How Stuff Works Airplanes (aircraft systems structure propulsion basics)
<https://science.howstuffworks.com>
- DJI Drone Design Overview (drone components performance multirotor systems)
<https://www.dji.com>
- NASA Engineering Design Process (engineering design problem solving aerospace systems)
<https://www.nasa.gov/stem>

4. Control Systems, Stability, and Maneuvering

- NASA Aircraft Control Systems (pitch roll yaw flight control dynamics)
<https://www.grc.nasa.gov>
- FAA Flight Controls Guide (control systems stability aircraft maneuvering basics)
<https://www.faa.gov>
- Skybrary Flight Control Systems (flight stability aircraft control systems safety)
<https://www.skybrary.aero>

- DJI Flight Control Systems (drone stabilization sensors control flight systems)
<https://enterprise.dji.com>

5. Navigation, Flight Planning, and Route Design

- GPS Government Resource (GPS navigation satellite positioning flight planning basics)
<https://www.gps.gov>
- FAA Navigation Handbook (navigation aids GPS RNAV aviation fundamentals)
<https://www.faa.gov>
- SkyVector Flight Planning (flight planning charts navigation route design)
<https://skyvector.com>
- DJI Waypoint Navigation (drone waypoint planning mission design navigation systems)
<https://www.dji.com>

6. Airspace, Regulations, and Legal Flight Operations

- FAA UAS Regulations (drone laws airspace rules compliance safety)
<https://www.faa.gov/uas>
- FAA Airspace Basics (airspace classification aviation operations rules)
<https://www.faa.gov>
- B4UFLY Airspace Tool (airspace awareness drone flight safety planning)
<https://www.b4ufly.aloft.ai>
- Skybrary Airspace Guide (controlled uncontrolled airspace aviation safety concepts)
<https://www.skybrary.aero>

7. Weather, Environment, and Flight Performance

- Aviation Weather Center (weather reports METAR TAF flight conditions forecasting)
<https://aviationweather.gov>
- NOAA Weather Service Aviation (weather hazards wind visibility aviation impacts)
<https://www.weather.gov>
- NASA Weather Systems Overview (atmosphere weather patterns aviation effects)
<https://climate.nasa.gov>
- UAV Forecast Tool (drone weather planning wind visibility flight conditions)
<https://www.uavforecast.com>

8. Safety, Risk Management, and Human Factors

- FAA Safety Risk Management Handbook (risk identification mitigation aviation safety decision making)
<https://www.faa.gov>
- FAA Human Factors Guide (fatigue stress decision making aviation safety)
<https://www.faa.gov>
- Skybrary Human Factors (human performance aviation safety errors mitigation)
<https://www.skybrary.aero>
- NASA Human Integration Design (human systems design safety aviation performance limits)
<https://www.nasa.gov>

9. Drone Systems, Autonomy, and Flight Technology

- DJI Drone Technology Overview (drone systems sensors autonomy flight technology)
<https://www.dji.com>
- NASA Autonomous Systems (autonomous flight robotics systems engineering)
<https://www.nasa.gov>
- DroneBlocks Autonomous Missions (drone coding waypoint automation systems)
<https://droneblocks.io>
- Arduino Robotics Projects (autonomous systems sensors programming engineering applications)
<https://projecthub.arduino.cc>

10. Operational Procedures and Real World Applications

- FAA Pilot Operating Handbook (flight procedures operations aviation safety guidelines)
<https://www.faa.gov>
- Skybrary Operational Procedures (aviation operations safety procedures standards)
<https://www.skybrary.aero>
- DJI Industry Applications (drone applications agriculture inspection media public safety)
<https://enterprise.dji.com>
- ESRI Drone Applications (mapping GIS drone applications real world use)
<https://www.esri.com>

11. Flight Systems and Drone Mission Project

- FAA Remote Pilot Study Guide (mission planning preflight airspace weather risk management)
https://www.faa.gov/sites/faa.gov/files/regulations_policies/handbooks_manuals/aviation/remote_pilot_study_guide.pdf
- NASA Unmanned Aircraft Systems Educator Guide (drone challenges mission design engineering problem solving)
<https://www.nasa.gov/stem-content/unmanned-aircraft-systems-educator-guide/>
- NASA Advanced Air Mobility STEM Toolkit (drones safety payload design quadcopters flight log activities)
<https://www.nasa.gov/advanced-air-mobility-aam-stem-toolkit/>
- AOPA Flight Planning Resources (flight planning weather navigation preflight decision making)
<https://www.aopa.org/training-and-safety/knowledge/flight-planning>

12. Leadership

- CareerOneStop Skills Assessment (workplace skills leadership teamwork communication self-assessment)
<https://www.careeronestop.org/ExploreCareers/Assessments/skills.aspx>
- CareerOneStop Work Values Matcher (leadership values workplace readiness teamwork decision making)
<https://www.careeronestop.org/Toolkit/Careers/work-values-matcher.aspx>

- Ethics Unwrapped Leadership (ethical leadership decision making responsibility professional conduct)
<https://ethicsunwrapped.utexas.edu/subject-area/leadership>
- Toastmasters Youth Leadership Program (public speaking leadership communication feedback confidence)
<https://www.toastmasters.org/education/youth-leadership-program>

13. Work-Based Learning

- ACTE What is Work-Based Learning Fact Sheet (career awareness exploration preparation internships apprenticeships)
<https://www.acteonline.org/blog/cte-policy-watch/new-resource-what-is-work-based-learning-fact-sheet/>
- Advance CTE Work-Based Learning Resources (experiential learning internships apprenticeships career pathways)
<https://careertech.org/resource-center/topics/work-based-learning/>
- U.S. Department of Labor Career Preparation and Work-Based Learning (career planning employability soft skills workplace experiences)
<https://www.dol.gov/agencies/odep/program-areas/individuals/youth/career-preparation>
- Young Worker Toolkit (workplace rights responsibilities youth employment safety readiness)
<https://www.dol.gov/agencies/whd/youthrules/young-worker-toolkit>



Technology Student Association – National Competitive Events

Flight Endurance

Objective: *Students will design, build, test, document, and fly a rubber-band-powered model aircraft that meets TSA Flight Endurance requirements for construction, inspection, documentation, and flight performance.*

- Research model aircraft design, flight technology, aerodynamics, propulsion, stability, endurance, and trim factors.
- Design and construct a model aircraft that meets TSA requirements for wingspan, chord, fuselage length, propeller size, weight, wheels, landing gear, and rubber motor.
- Prepare a flight box that safely contains the model and meets TSA size requirements.
- Maintain a flight log documenting previous test flights, winds, time aloft, flight pattern, and trim adjustments.
- Prepare a documentation portfolio that includes technical attributes, part identification, modification analysis, assembly drawings, and scaled engineered drawings.
- Conduct test flights and make trim adjustments to improve endurance, stability, and landing performance.
- Participate in official flight trials, inspection, and scoring procedures using TSA competition criteria.

Resources

- Technology Student Association – Flight Endurance competition guidelines
<https://tsaweb.org/competitions-programs/tsa/themes-problems>
- NASA Glenn Research Center – Beginner’s Guide to Aeronautics
<https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/>
- Academy of Model Aeronautics – Model aircraft and flight resources
<https://www.modelaircraft.org/>
- National Free Flight Society – Free-flight aircraft resources
<https://freeflight.org/>



Technology Student Association – National Competitive Events

Geospatial Technology

Objective: *Students will collect, analyze, map, synthesize, and defend geospatial data in response to the annual TSA Geospatial Technology challenge.*

- Research the annual TSA Geospatial Technology challenge and identify the geographic issue or prediction being investigated.
- Collect geospatial data such as imagery, boundaries, transportation data, earth observations, historical maps, or basemaps.
- Use an online mapping platform to represent and analyze geospatial data.
- Prepare a digital documentation portfolio explaining the challenge, collected data, analysis maps, prediction, resources, and work log.
- Create a visual infographic map that communicates the predicted outcome and clearly supports it with data.
- Present and defend the team's prediction during the semifinal presentation/interview.
- Evaluate the final entry using TSA criteria for data use, prediction quality, visual communication, analysis, creativity, and presentation.

Resources

- Technology Student Association – Geospatial Technology competition guidelines
<https://tsaweb.org/competitions-programs/tsa/themes-problems>
- ArcGIS Online – Mapping and geospatial analysis tools
<https://www.arcgis.com/>
- NASA Earthdata – Earth observation and geospatial data
<https://www.earthdata.nasa.gov/>
- NOAA Aviation Weather Center – Aviation weather data and forecasts
<https://aviationweather.gov/>



Technology Student Association – National Competitive Events

Extemporaneous Speech

Objective: *Students will prepare and deliver a timed speech on a selected TSA topic using effective organization, technical understanding, and professional communication skills.*

- Review TSA Extemporaneous Speech procedures, expectations, time limits, and evaluation criteria.
- Prepare to speak on a range of STEM, technology, engineering, leadership, or current-issue topics.
- Select or receive a topic and organize a clear speech within the allotted preparation time.
- Develop a focused introduction, logical supporting points, and a concise conclusion.
- Deliver a three-to-five-minute speech using professional voice, pacing, body language, and audience awareness.
- Address the selected topic with relevant content, reasoning, examples, and technical vocabulary.
- Evaluate the speech using TSA criteria for delivery, content, organization, time adherence, and overall communication effectiveness.

Resources

- Technology Student Association – Extemporaneous Speech competition guidelines
<https://tsaweb.org/competitions-programs/tsa/themes-problems>
- National Speech & Debate Association – Public speaking resources
<https://www.speechanddebate.org/>
- Federal Aviation Administration – Pilot’s Handbook of Aeronautical Knowledge
<https://www.faa.gov/regulationspolicies/handbooksmanuals/aviation/phak>
- NASA Aeronautics – Aviation and flight research resources
<https://www.nasa.gov/aeronautics/>