Aerospace Engineering - UAS

Level: 3
Career Cluster: Advanced Manufacturing
Program: Engineering
Pathway(s): Engineering Applications UAS, Aerospace Engineering Technician
Aligns with: EGG 1025 Principles of Aerospace

Course Catalog Description

Introduces students to aerospace engineering and the design of air and space systems while incorporating unmanned aircraft systems (UAS) as a secondary application area. Students build technical knowledge and professional skills through aerospace and drone-related projects and problem-solving.

Summary

This course provides students with a comprehensive introduction to aerospace engineering through the study of career pathways, foundational engineering principles, and the design of air and space systems. Students explore aerospace engineering technician roles, postsecondary opportunities in Colorado, professionalism, ethics, and industry expectations while building knowledge of aeronautical and astronautical engineering, aircraft systems, rocketry, launch vehicles, orbital mechanics, satellites, and CubeSat applications. As a secondary strand, students also examine how unmanned aircraft systems (UAS) connect to aerospace engineering through flight operations, safety, regulation, navigation, sensing, and real-world data collection applications. Through the engineering design process, students apply math, physics, computational tools, modeling, and testing to analyze problems, evaluate constraints and trade-offs, interpret data, and improve solutions based on evidence and feedback. The course also emphasizes collaboration, technical communication, project planning, and documentation, preparing students to present engineering ideas clearly and work effectively in teams. In addition, students examine the safety, sustainability, societal, political, and global impacts of aerospace technologies and emerging drone applications to better understand the responsibilities and opportunities associated with the field.

Notes

This revised course expands the previous course by organizing content into more clearly defined sections with objectives and detailed student outcomes, while also positioning unmanned aircraft systems (UAS) as a secondary application strand throughout the course rather than as a limited topical reference. Compared with the older version, the updated document adds stronger emphasis on career exploration, technical communication, computational tools, societal and global impacts, and a culminating final assessment project, while also introducing distinct sections for leadership and work-based learning to better reflect current CTE expectations and student readiness goals. The result is a more comprehensive, structured, and industry-connected course framework than the earlier outline.

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 Aerospace Engineering

Objective: *Students will explain and apply foundational aerospace engineering principles to understand how air, space, and selected unmanned aircraft systems are designed and operated.*

5) Explain the core principles of aerospace engineering and how they apply to selected UAS technologies.
6) Describe the major disciplines within aerospace engineering.
7) Apply basic math and physics concepts to aerospace engineering problems.
8) Differentiate between aeronautical and astronautical engineering applications.

3. Engineering Design and Problem-Solving Process

Objective*: Students will apply the engineering design process to solve aerospace-related problems through iterative design and testing, including selected drone and UAS design scenarios.*

9) Apply the engineering design process to aerospace challenges, including selected drone or UAS applications.
10) Analyze design constraints, requirements, and trade-offs.
11) Evaluate potential engineering solutions using data and testing results.
12) Revise designs based on performance outcomes and feedback.

4. Aeronautical Engineering Systems

Objective: *Students will analyze aircraft and selected unmanned aircraft systems to understand aerodynamic principles, stability, control, and propulsion.*

13) Explain aircraft and UAS stability and control concepts.
14) Analyze trim speed and aircraft response to control inputs.
15) Describe basic propulsion systems used in aircraft and small unmanned aircraft systems.
16) Apply aerodynamic principles to predict aircraft behavior in flight.

5. Rocketry and Launch Systems

Objective: *Students will analyze rocket systems and propulsion principles to understand space launch operations.*

17) Describe different types of rocket engines.
18) Explain the ideal rocket equation and its purpose.
19) Analyze rocket stability and control during launch.
20) Compare launch vehicle designs based on mission requirements.

6. Space Systems and Orbital Mechanics

Objective: *Students will apply principles of space engineering and orbital mechanics to analyze satellite systems and missions.*

21) Explain basic orbital mechanics concepts.
22) Analyze satellite motion and maneuvering strategies.
23) Identify major satellite subsystems and their functions.
24) Apply systems thinking to evaluate satellite performance.

7. Satellite Subsystems and Applications

Objective: *Students will analyze satellite subsystem design and applications, including CubeSats and space weather considerations.*

24) Describe satellite power, thermal, structure, and communication subsystems.
25) Analyze how space weather affects satellite operations.
26) Evaluate satellite designs for specific mission goals.
27) Explain real-world satellite and CubeSat applications.

8. Professional Engineering Skills and Teamwork

Objective: *Students will demonstrate professional engineering behaviors through teamwork, communication, and ethical practice.*

28) Apply teamwork strategies to collaborative engineering projects.
29) Demonstrate time management and project planning skills.
30) Explain ethical responsibilities of aerospace engineers.
31) Evaluate the role of safety and sustainability in engineering decisions.

9. Technical Communication and Documentation

Objective: *Students will create clear technical documentation and presentations that communicate aerospace engineering work.*

32) Apply technical writing conventions to engineering reports.
33) Create design documentation and project summaries.
34) Present engineering concepts using appropriate visuals and terminology.
35) Revise documentation based on peer and instructor feedback.

10. Computational Tools, Modeling, and Testing

Objective: *Students will apply mathematical and software tools to model, test, and evaluate aerospace systems.*

36) Apply mathematical models to aerospace problems.
37) Use software tools to analyze aerospace designs.
38) Interpret test data from simulations or physical models.
39) Evaluate system performance using empirical evidence.

11. Societal, Political, and Global Impacts of Aerospace Technology

Objective: *Students will evaluate the societal and political implications of aerospace technologies.*

40) Explain how aerospace technology impacts society and global systems.
41) Analyze political and economic influences on aerospace development.
42) Evaluate ethical considerations related to aerospace innovation.
43) Discuss future challenges and opportunities in aerospace engineering.

12. Final Assessment Project

Objective: *Students will synthesize aerospace engineering knowledge and technical skills to complete and present a comprehensive final project that demonstrates design thinking, problem-solving, and professional communication.*

44) Design and complete a final aerospace engineering project that addresses a defined problem, challenge, or mission scenario.
45) Apply aerospace engineering concepts, data, tools, and testing methods to develop and refine the final project.
46) Produce project documentation that explains design choices, processes, results, and revisions.
47) Present the final project to an audience using appropriate technical language, visuals, and evidence.

13. Leadership

Objective: *Students will develop leadership skills that support responsible decision-making, collaboration, initiative, and contributions to classroom, CTSO, and workplace settings.*

48) Demonstrate leadership behaviors such as initiative, accountability, ethical decision-making, and effective communication.
49) Apply conflict resolution, collaboration, and team-building strategies in academic and project-based settings.
50) Participate in leadership opportunities through CTSO, classroom projects, or community-based experiences.
51) Reflect on personal strengths, growth areas, and contributions as a leader and team member.

14. Work-Based Learning

Objective: *Students will connect classroom learning to industry expectations through work-based learning experiences, career readiness activities, and reflection on professional practice in aerospace engineering and related fields.*

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2) Identify the purpose and value of work-based learning experiences such as job shadows, internships, mentorships, and industry engagement.
53) Demonstrate workplace readiness skills including punctuality, communication, professionalism, and adaptability.
54) Apply classroom knowledge and technical skills to authentic industry-informed tasks or scenarios.
55) Reflect on work-based learning experiences to evaluate career interests, skill development, and next steps.

15. 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: Aerospace Engineering
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; pose thoughtful questions, acknowledge the ideas of others; and contribute ideas to further the group's attainment of an objective.	Students work in engineering teams on complex aerospace problems, including selected drone and UAS design or flight-planning scenarios, collaborating during design, testing, and problem-solving activities while listening to and integrating peer feedback to contribute ideas toward shared project goals.
Standard 1: Oral Expression and Listening	Prepared Graduate 2 – Oral Presentations	Deliver effective oral presentations for varied audiences and varied purposes.	Students present aerospace engineering solutions and system designs, explain technical concepts such as aerodynamics, systems engineering,

			astronautics, and selected UAS applications, and communicate results and design decisions clearly to peers and instructors.
Standard 2: Reading for All Purposes	Prepared Graduate 4 – Informational Texts	Read a wide range of informational texts to build knowledge and to better understand the human experience.	Students read and interpret technical aerospace, engineering, and introductory UAS texts, use industry manuals, standards, and specifications, and analyze scientific and engineering documentation related to air and space systems to build knowledge and support understanding.
Standard 2: Reading for All Purposes	Prepared Graduate 5 – Language in Context	Understand how language functions in different contexts, command a variety of word-learning strategies to assist comprehension, and make effective choices for meaning or style when writing and speaking.	Students use discipline-specific aerospace and engineering terminology accurately, adjust language for technical, analytical, and presentation contexts, and choose precise wording to communicate engineering explanations with clarity.
Standard 3: Writing and Composition	Prepared Graduate 6 – Craft arguments	Craft arguments using techniques specific to the genre.	Students justify engineering design decisions using data and constraints, defend aerospace system solutions and performance

			tradeoffs, and support claims with evidence drawn from analysis and testing.
Standard 3: Writing and Composition	Prepared Graduate 7 – Informational Writing	Craft informational/explanatory texts using techniques specific to the genre.	Students produce engineering reports, write technical explanations of aerospace systems and processes, and document design rationale, analysis, and results in formats appropriate to professional engineering communication.
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 refine technical documentation to produce polished, accurate, professional engineering writing that meets industry and academic standards for clarity and correctness.
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 to answer complex questions.	Students research aerospace technologies, systems, and applications; analyze data and information to inform engineering decisions; and use sources ethically to support the design, testing, and evaluation of aerospace and selected drone/UAS solutions.

Free Resource Links

1. Career Exploration and Postsecondary Opportunities

- PROPEL Colorado (Colorado aerospace pathways and workforce) https://coloradosbr.org/propel-co/
- My Colorado Journey – Aerospace (career pathway exploration) https://www.mycoloradojourney.com/industries/aerospace
- AIAA Careers in Aerospace (career info and student pathways) https://www.aiaa.org/careers/
- FAA Educational Users (school and classroom drone guidance) https://www.faa.gov/uas/educational_users

2. Foundations of Aerospace Engineering

- OpenStax University Physics Volume 1 (mechanics and gravitation) https://openstax.org/details/books/university-physics-volume-1/
- NASA Glenn Beginner's Guide to Aeronautics (aerodynamics and flight basics) https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/
- NASA Unmanned Aircraft Systems Educator Guide (UAS engineering and STEM activities) https://www.nasa.gov/stem-content/unmanned-aircraft-systems-educator-guide/

3. Engineering Design and Problem-Solving Process

- NASA Engineering Design Process – Classroom Connections (engineering design process PDF) https://www.nasa.gov/wp-content/uploads/2023/03/engineering-design-process-classroom-connections-508.pdf
- TeachEngineering Design Process Hub (lesson plans and activities) https://www.teachengineering.org/populartopics/designprocess
- DroneBlocks STEM Curriculum (drone coding and autonomous flight design) https://droneblocks.io/

4. Aeronautical Engineering Systems

- NASA Glenn Beginner's Guide to Aeronautics (aerodynamics, propulsion, wind tunnels) https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/
- NASA FoilSim (airfoil lift/drag simulator) https://www.nasa.gov/stem-content/foilsim/
- PhET Projectile Motion (modeling trajectories) https://phet.colorado.edu/en/simulation/projectile-motion

5. Rocketry and Launch Systems

- NASA Glenn Beginner's Guide to Rockets (rocket basics and stability) https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/guide-to-rockets/
- MIT OpenCourseWare 16.512 Rocket Propulsion (lecture notes) https://ocw.mit.edu/courses/16-512-rocket-propulsion-fall-2005/

- OpenStax College Physics – Rocket Propulsion (intro to rocket propulsion) https://openstax.org/books/college-physics-2e/pages/8-7-introduction-to-rocket-propulsion

6. Space Systems and Orbital Mechanics

- MIT OpenCourseWare 16.346 Astrodynamics (orbital mechanics course) https://ocw.mit.edu/courses/16-346-astrodynamics-fall-2008/
- OpenStax University Physics (gravitation and orbits) https://openstax.org/details/books/university-physics-volume-1/
- Khan Academy Orbital Motion (video lesson) https://www.khanacademy.org/science/highschool-physics/x6679aa2c65c01e53:gravitation/x6679aa2c65c01e53:orbital-motion/v/orbital_motion

7. Satellite Subsystems and Applications

- NASA CubeSat 101 (CubeSat basics PDF) https://www.nasa.gov/wp-content/uploads/2017/03/nasa_csli_cubesat_101_508.pdf
- The Aerospace Corporation STEM Teacher Resources (satellite/CubeSat lessons) https://aerospace.org/stem/teacher-resources
- NOAA Space Weather Education and Outreach (space weather impacts) https://www.swpc.noaa.gov/content/education-and-outreach

8. Professional Engineering Skills and Teamwork

- NASA Systems Engineering Handbook (systems thinking PDF) https://www.nasa.gov/wp-content/uploads/2018/09/nasa_systems_engineering_handbook_0.pdf
- NSPE Code of Ethics (professional ethics) https://www.nspe.org/career-growth/ethics/nspe-code-ethics-engineers
- NIST Measurement Uncertainty (data quality and uncertainty) https://physics.nist.gov/cuu/Uncertainty/index.html

9. Technical Communication and Documentation

- Purdue OWL Technical Writing (reports and documentation) https://owl.purdue.edu/owl/subject_specific_writing/professional_technical_writing/index.html
- NASA Systems Engineering Handbook (technical documentation examples) https://www.nasa.gov/wp-content/uploads/2018/09/nasa_systems_engineering_handbook_0.pdf
- AIAA Careers resources (professional communication and expectations) https://www.aiaa.org/careers/

10. Computational Tools, Modeling, and Testing

- Python for Everybody (Python programming course) https://www.py4e.com/

- NASA Earthdata Tutorials/Trainings (data analysis and visualization) https://www.earthdata.nasa.gov/learn/trainings
- PhET simulations (interactive STEM simulations) https://phet.colorado.edu/en/simulations/filter?subjects=physics

11. Societal, Political, and Global Impacts of Aerospace Technology

- NASA Learning Resources (space and society learning materials) https://www.nasa.gov/learning-resources/
- UNOOSA Space Law eLearning (international space law basics) https://www.unoosa.org/oosa/en/ourwork/spacelaw/capacitybuilding/advisory-services/elearning.html
- UNOOSA Outer Space Treaty overview (treaty principles and norms) https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html
- NSPE Board of Ethical Review Cases (ethics case studies) https://www.nspe.org/career-growth/ethics/board-ethical-review-cases

12. Final Assessment Project

- NASA eClips Engineering Design Packets Implementation Guide and Rubric (engineering design packet, learner checklist, and rubric) https://assets.science.nasa.gov/content/dam/science/cds/eclips/assets/documents/engineering-design-packet-implementation-guide-and-rubrics.pdf
- NASA Engineering Design Challenges from Glenn Research Center (NASA-inspired design challenges and assessment options) https://www.nasa.gov/stem-content/engineering-design-challenges-from-nasas-glenn-research-center/
- Invention League High School Engineering Design Process Portfolio Scoring Rubric (high school engineering portfolio and capstone assessment rubric) http://www.inventionleague.org/wp-content/uploads/HS_EDPL_Rubric.pdf
- PJAS Engineering Presentation Rubric (engineering presentation criteria and scoring guide) https://pjas.org/wp-content/uploads/2026/01/PJAS_Rubric_Engineering.pdf

13. Leadership

- Skills to Succeed Academy – Leadership (teamwork, communication, and leadership skill-building) https://skillstosucceedacademy.accenture.com/en-us/course-catalog/communication/leadership
- MindTools Leadership Skills (leadership strategies, collaboration, and decision-making) https://www.mindtools.com/pages/main/newMN_LDR.htm
- NEA Student Leadership Resources (student leadership development and school-based leadership ideas) https://www.nea.org/professional-excellence/student-engagement/tools-tips/student-leadership

14. Work-Based Learning

- Advance CTE Work-Based Learning Toolkit (work-based learning models and implementation guidance)
  https://careertech.org/resource/work-based-learning-toolkit/
- CareerOneStop Learn About Apprenticeships (career readiness and workplace learning pathways)
  https://www.careeronestop.org/ExploreCareers/Plan/apprenticeships.aspx
- U.S. Department of Labor YouthRules! (workplace readiness, safety, and employment guidance for students)
  https://www.youthrules.gov/

Technology Student Association – National Competitive Events

Engineering Design

Objective: *Students will research a grand engineering challenge, develop and test a prototype or model, document the engineering design process, and present a solution aligned with TSA Engineering Design competition requirements.*

- Research the annual TSA Engineering Design theme and connect it to one of the National Academy of Engineering Grand Challenges.
- Identify a specific engineering problem with clear goals, constraints, users, and design requirements.
- Develop alternative solutions and select a preferred design using research, testing, and engineering reasoning.
- Create and test a prototype or model that represents the proposed engineering solution.
- Prepare a documentation portfolio that records research, design development, testing, revisions, and final decisions.
- Create a display that clearly communicates the problem, prototype/model, design process, and final solution.
- Deliver a team presentation and respond to judge questions about the engineering solution, design decisions, and project impact.

Resources

- Technology Student Association – Engineering Design competition guidelines https://tsaweb.org/competitions-programs/tsa/themes-problems
- National Academy of Engineering – Grand Challenges for Engineering https://www.engineeringchallenges.org/
- NASA Engineering Design Process https://www.nasa.gov/stem-content/engineering-design-process/
- Autodesk Fusion – CAD, modeling, simulation, and prototyping tools https://www.autodesk.com/products/fusion-360/education

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

Technology Problem Solving

Objective: *Students will work as a team to solve an on-site TSA technology challenge by designing, constructing, testing, and evaluating a solution using limited materials, tools, and time.*

- Analyze an on-site TSA problem and identify the required task, constraints, materials, and scoring criteria.
- Collaborate with a partner to plan and construct a working solution within the competition time limit.
- Use approved materials, tools, and measuring devices safely and effectively during the build process.
- Apply engineering and technology concepts to improve the performance of the solution.
- Test the solution using the required objective measure, such as strength, distance, time, accuracy, or completion of a task.
- Revise the solution based on observed performance and available time.
- Evaluate the final product using TSA criteria for problem solving, construction quality, teamwork, and measurable performance.

Resources

- Technology Student Association – Technology Problem Solving competition guidelines https://tsaweb.org/competitions-programs/tsa/themes-problems
- NASA STEM Engagement – Engineering design challenges https://www.nasa.gov/learning-resources/
- TeachEngineering – Hands-on engineering design challenges https://www.teachengineering.org/
- Science Buddies – Engineering Design Process https://www.sciencebuddies.org/science-fair-projects/engineering-design-process/engineering-design-process-steps