UAS: Design and Maintain

Exam Information	Description
Exam number **672** **Items** **26** **National Career Cluster** **Supply Chain & Transportation** **Digital Technology** **Certification available** **No, in Pilot status**	This course explores aviation principles while designing and testing a drone. It combines engineering processes and aviation principles into a hands-on course specifically created for the exploration of Unmanned Aircraft Systems in a variety of industries.

Exam Blueprint and Performance Skills

Standard	Percentage of exam score
1. Construction Techniques	28%
2. Components and Aerodynamics	36%
3. UAS Programming	13%
4. Design Process	8%
5. UAS MX Documentation	4%
6. Careers	11%

Standard 1 - Construction Techniques (28% of exam score)

Candidates will understand drone construction techniques including safety techniques, tools identification, material usage, and soldering skills.

Objective 1 Identify tools/equipment and their uses.

1. • Drivers & screws (philips, flathead, robertson, torque, hex)
2. • Soldering iron and solder
3. • Needle-nose pliers
4. • Wire strippers
5. • Wrenches (adjustable, crescent)
6. • Heat gun
7. • Multimeter
8. • Hot glue gun
9. • Blades
10. • Measuring devices (calipers, ruler)

Objective 2 Distinguish the difference and convert between metric and imperial units of measurement.

Objective 3 Identify UAS materials, their uses, and their unique construction and repair techniques (foamboard, carbon fiber, fiberglass, composites, etc.)

Objective 4 Identify soldering techniques and safety skills as applied to drones.

1. • Tinning
2. • Splicing
3. • Applications (jumper wires, battery connectors, Printed Circuit Boards (PCBs), header pins, bullet connectors)
4. • Heat shrink
5. • Positive, negative, and signal wiring and colors related to solder connections
6. • Clean, industry-standard solder

Performance Skills

1. • Demonstrate proper tool safety by following Standard Operating Procedures.
2. • Safely construct an object using basic construction materials (foamboard, molded plastic, 3D print, composites, etc.).
3. • Solder and test a simple circuit.
4. • Demonstrate a clean and safe solder with multiple gauge wires.
5. • Demonstrate a clean and safe solder to a battery connector.
6. • Make a measurement to millimeter accuracy using a measuring tool.
7. • Pass relevant safety tests with 100% accuracy.

Standard 2 - Components and Aerodynamics (36%)

Candidates will gain an understanding of the basic components for UAS and what terminology is used in the field. Students will also understand how these components help facilitate aerodynamic principles for all kinds of UAS.

Objective 1 Identify basic UAS components and their uses..

1. • Servo (leads, arms)
2. • Control horn and control rod
3. • Flight controller
    a. Battery Eliminator Circuit (BEC)
4. • Motor (brushed, brushless)
5. • Electronic Speed Control (ESC)
6. • Propeller
7. • Battery (charging, conversion, connectors)
8. • Sensors/payloads (VTX, camera, LIDAR, GPS, etc.)
9. • Frames (types, shapes, materials, landing gear)

Objective 2 Match motors, batteries, ESCs, and propellers for a functioning UAS considering factors such as current limits, connector types, and part sizes.

Objective 3 Identify aerodynamic principles in multiple types of UAVs.

1. • Four forces of flight (lift, drag, thrust, weight)
    a. • Loading and balance
    b. • Center of gravity
2. • Flight maneuvers
    a. • Control surface movement (fixed-wing)
    b. • Motor direction (multirotor)
    c. • Vertical takeoff and landing (VTOL) vehicles

Performance Skills

1. • Demonstrate flight principles using a student-constructed drone.
2. • Describe how changes in design and construction impact aerodynamics.
3. • Find and identify component specifications in order to distinguish compatible components.

Standard 3 - UAS Programming (13%)

Candidates will understand the assembly, integration, and calibration of UAS components.

Objective 1 Identify UAS Transmitter (TX) and Receiver (RX) functions.

1. • Protocols
2. • PWM, PPM, SBUS, IBUS
3. • Open Source programming (Betaflight, iNav, Adrupilot, Mission Planner)
4. • Mode Switching
5. • Types and Uses
6. • Programming Basics (failsafe, initial setup, throttle cut, reversing servos)

Objective 2 Compare transmitter/receiver binding techniques and identify troubleshooting practices.

Objective 3 Show knowledge of Electronic Speed Controller (ESC) calibration.

1. Standard calibration protocol using sound indicators

Objective 4 Assess Proportional-Integral-Derivative (PID) loops and motor tuning and how to use them in an iterative process.

Performance Skills

1. • Successfully pair a transmitter and receiver on two different systems.
2. • Present solution steps and/or mitigation steps of an unpairing mid-flight event.
3. • Demonstrate switching modes on a transmitter.
4. • Modify the programmed performance of a motor.

Standard 4 - Design Process (8%)

Candidates will use the Engineering Design Process (EDP) to design UAS modifications with an intended purpose in mind.

Objective 1 Examine the steps of the Engineering Design Process (EDP).

1. Identify and define the problem
2. Brainstorm solutions
3. Create a model
4. Test the prototype
5. Iteration
6. Communicate results

Objective 2 Determine a goal of increased efficiency in one or more metrics of drone performance.

Performance Skills

1. • Use the EDP to demonstrate a modification to a drone that achieves an intended goal.
2. • Present design ideas utilizing knowledge of motors, batteries, ESCs, and propellers.
3. • Design a UAS from scratch and justify methods, material choices, and cost.
4. • (optional) Build a student-designed UAV.

Standard 5 - UAS MX Documentation (4%)

Candidates will demonstrate maintenance (MX) documentation techniques and skills related to UAS building and/or MX.

Objective 1 Recognize documentation elements in a build or repair process.

Objective 2 Identify the uses and importance of a MX log.

Objective 3 Define preventative MX as it relates to UAS.

Performance Skills

1. • Present build or repair documentation.
2. • Maintain an appropriate MX log book.
3. • Using a UAV manual, summarize the drone's preventative maintenance.

Standard 6 - Careers (11%)

Candidates will explore potential careers related to UAS maintenance and design.

Objective 1 Candidates will explore differences in aircraft that allow them to perform specialized tasks.

1. • Quad or Multi-Rotor Vertical Takeoff
2. • Racing (First Person View)
3. • Fixed-Wing
4. • Mini
5. • Emerging technology drones
6. • Other Unmanned Systems

Objective 2 Explore careers related to the UAS maintenance industry.

1. • Drone Engineer
2. • Drone Technician
3. • UAS Software Developer
4. • UAS Hardware Designer
5. • Drones Sales Specialist
6. • UAS Maintenance Specialist

Performance Skills

1. • Present a personalized UAS post-secondary plan (college or career).
2. • Pass The Recreational UAS Safety Test (TRUST).