TN Department of Education | College, Career and Technical Education

May 2025

Career Cluster:

Transportation

Maintenance and Light Repair I (MLR I)

Primary Career Cluster:	Transportation
Course Contact:	CTE.Standards@tn.gov
Course Code:	C20H09
Prerequisite:	None
Credit:	1
Grade Level:	9
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Transportation courses.
Program of study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Program of Study and Sequence:	This is the first course in the *Automotive Maintenance and Light Repair* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	506, 508, 770
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-transportation-distribution-logistics.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstrations. These include Career Pathways Showcase, Job Interview, Maintenance Light Repair, and Automotive Service Technology.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standard 3.1** | Include a safety briefing in a visit to a shop.
- **Standard 4.1** | Have a technician discuss the tools they use on the job.
- **Standard 5.1** | Have a service manager discuss how they prepare a vehicle for service.
- **Standards 6.3, 6.7, 6.9** | Have a technician discuss basic service and maintenance.
- **Standards 7.3, 7.4** | Visit a shop that allows the students to help rotate and balance tires.

Course Description

The *Maintenance and Light Repair I (MLR I)* course prepares students for entry into *Maintenance and Light Repair II*. Students explore career opportunities and requirements of a professional service technician. Content emphasizes beginning transportation service skills and workplace success skills. Students study safety, tools, equipment, shop operations, basic engine fundamentals, and basic technician skills. Upon completing all of the *Maintenance and Light Repair* courses, students may enter the automotive service industry as an Automotive Service Excellence (ASE) Certified MLR Technician.

Hours earned in the *Maintenance and Light Repair* courses may be used toward meeting ASE Education Foundation standards and Tennessee Department of Education standards. ASE requires that 95% of the P-1 tasks, 80% of the P-2 tasks, and 50% of the P-3 tasks will be accomplished. These tasks are notated in these standards.

Course Standards

1. Safety

1.1 Personal Protective Equipment: **Use and inspect personal protective equipment** and demonstrate appropriate related safety procedures.

1.2 Safe Operating Procedures: Inspect, maintain, and **employ safe operating procedures** with tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment.

1.3 Hazards: Demonstrate continuous awareness of **potential hazards** to self and others and respond appropriately.

1.4 Hazcom: Assume responsibilities under **HazCom (Hazard Communication) regulations**.

1.5 OSHA: Adhere to responsibilities, regulations, and **Occupational Safety & Health Administration (OSHA) policies** to protect coworkers and bystanders from hazards; report accidents and observed hazards; and comply with emergency response procedures.

1.6 Safety Exam: **Pass a performance examination with 100% accuracy,** relating to safety issues specific to Maintenance and Light Repair.

2. Leadership, Citizenship, and Teamwork

2.1 Leadership: Cultivate positive leadership skills. **Practice and demonstrate personal leadership skills.** For example, take advantage of opportunities provided by a career and technical student organization (CTSO), such as SkillsUSA.

2.2 Problem-Solving: Assess situations and **apply problem-solving techniques** and decision-making skills within the school, community, and workplace.

2.3 Cooperation: Participate as a **team member** in a learning environment.

2.4 Respect Others: **Respect the opinions, customs, and individual differences of others.**

2.5 Personal Interests: **Identify career interests**, strengths, and opportunities.

2.6 Career and Technical Student Organization Introduction: **Introduce the program's aligned CTSO**, SkillsUSA, through an interactive activity, such as a classroom competition.

3. Shop and Personal Safety

3.1 Shop Safety: Identify and demonstrate knowledge of how to **utilize marked safety areas and equipment**, such as location and use of eyewash stations, first aid kit, types of fire extinguishers and other fire safety equipment, posted evacuation routes, and proper ventilation procedures for working within the lab/shop area.

3.2 Personal Safety: Comply with the required use of **safety glasses, ear protection, gloves, appropriate clothing, and shoes** during lab/shop activities; demonstrate knowledge of procedures for securing hair and jewelry for lab/shop activities.

3.3 Systems Safety: Demonstrate **awareness of the safety aspects of supplemental restraint systems (SRS), electronic brake control systems, and hybrid vehicle high voltage circuits.**

3.4 Safety Data Sheets: Locate and demonstrate knowledge of **safety data sheets (SDS).**

4. Hand Tools, Power Tools, and Shop Equipment

4.1 Tools: **Identify tools** and their usage in automotive applications.

4.2 Measurements Systems: Identify **standard and metric** designation.

4.3 Use Tools: Demonstrate safe handling and **use of appropriate tools**.

4.4 Care of Tools: Demonstrate **proper cleaning, storage, and maintenance of tools** and equipment.

4.5 Measuring Tools: Demonstrate **proper use of precision measuring tools** (i.e. micrometer, dial-indicator, dial-caliper).

5. Prepare a Vehicle for Service

5.1 Identify Work Needed: Identify the information needed and the **service requested on a repair order**.

5.2 Protective Covers: Identify the purpose and demonstrate **proper use of fender covers, and mats**.

5.3 Three C's: Demonstrate the use of the three C's: **concern, cause, and correction**.

5.4 Vehicle History: Review **vehicle service history**.

5.5 Work Order: **Complete work order** to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.

6. Basic Vehicle Engine Service and Maintenance

6.1 Vehicle Information: Research **applicable vehicle and service information**, vehicle service history, service precautions, and technical service bulletins. (P-1)

6.2 Warning Indicators: Verify the operation of **the instrument panel engine warning indicators**. (P-1)

6.3 Leaks: **Inspect engine assembly for fuel, oil, coolant, and other leaks**, and determine necessary action. (P-1)

6.4 Engine Covers: **Install engine covers** using gaskets, seals, and sealers as required. (P-1)

6.5 Fastener Repair: Perform common **fastener and thread repair** to remove broken bolts, restore internal and external threads, and repair internal threads with thread insert. (P-1)

6.6 Hybrid Precautions: **Identify hybrid vehicle internal combustion engine service precautions**. (P-3)

6.7 Cooling System: Perform **cooling system pressure** and dye tests to identify leaks; **check coolant condition and level**; inspect and test radiator, pressure cap, coolant recovery tank, and heater core; determine necessary action. (P-1)

6.8 Belts: Inspect, replace, and adjust **drive belts, tensioners, and pulleys**; check pulley and belt alignment. (P-1)

6.9 Thermostat: Remove, inspect, and replace the **thermostat** and gasket/seal. (P-1)

6.10 Coolant: Inspect and test coolant; drain and recover coolant; **flush and refill cooling system** with recommended coolant; bleed air as required. (P-1)

6.11 Oil Change: Perform **engine oil and filter change**. (P-1)

7. Tires and Wheels

7.1 Inspect Tires: **Inspect tire condition**; identify tire wear patterns; check for correct size and application (load and speed ratings); adjust air pressure; and determine necessary action.

7.2 Rotate Tires: **Rotate tires** according to the manufacturer's recommendations.

7.3 Balance Tires: **Dismount, inspect, and remount the tire on the wheel**; balance wheel and tire assembly (static and dynamic).

7.4 Tires on TPMS: **Dismount, inspect, and remount the tire on the wheel equipped with a tire pressure monitoring system (TPMS)** sensor.

7.5 Air Loss: Inspect tire and wheel assembly for **air loss**; perform necessary action.

7.6 Patch Tire: **Repair the tire** using an internal patch.

7.7 TPMS Operation: Identify and test **tire pressure monitoring systems** (indirect and direct) for operation; verify operation of instrument panel lamps.

7.8 TPMS Sensors: Demonstrate knowledge of steps required to **remove and replace sensors** in a tire pressure monitoring system.

8. Diagnostic Challenge

8.1 Identify and Troubleshoot: Interact with a series of diagnostic challenges to **identify and troubleshoot** common automotive problems.

8.2 Diagnose: **Use diagnostic tools and techniques** as part of hands-on stations to diagnose issues such as engine misfires, electrical faults, and brake system malfunctions.

8.3 Diagnostic Process: **Document the diagnostic process** and findings, including observations, measurements, and test results, with other artifacts for inclusion in a program portfolio.

9. Data Analysis and Artificial Intelligence

9.1 Data Analysis in Transportation: **Research the use of data** in the transportation career fields. Include data that is generated internally by businesses, and externally by local communities, state, and the nation. Explore examples of how data is used, including the following:

a. customer/client use of products and services in automotive maintenance;
b. demographics of end users of automotive maintenance facilities;
c. community, state, and national statistics related to automotive maintenance; and
d. data that must be reported to another activity that impacts automotive maintenance.

9.2 Ethical Artificial Intelligence (AI): **Explore the ethical implications of AI usage** through interactive discussions and case studies, learning to identify bias, ensure fairness, and protect privacy in AI systems. **Develop** critical thinking **skills to evaluate the societal impact of AI technologies**, while fostering a sense of responsibility and ethical decision-making in the use of AI tools.

Teacher Resources

The following resources are available to assist teachers of this course.

- *Development Guidance: Classroom Activities*, Center on Education and Work, Madison, WI
- *Instructor Guide,* Automotive Service Excellence (ASE), http://aseinstructorguide.com/
- *Introduction to Transportation Service Technology*, Service Series, Curriculum and Instructional Material Center (CIMC), Oklahoma Department of Vocational and Technical Education
- *Module 1 Introduction to Transportation Technology*, Instructional Materials Laboratory (IML), University of Missouri
- *Today's Technician Basic Transportation Service & Systems*, Webster & Owens, Delmar/ITP
- 2022 Automotive Standards, Automotive Service Excellence (ASE), https://www.aseeducationfoundation.org/resources
- General Motors Diagnostic Plan
- Ford Motor Company Diagnostic Plan
- Harley Davidson Institute

Maintenance and Light Repair II (MLR II)

Primary Career Cluster:	Transportation
Course Contact:	CTE.Standards@tn.gov
Course Code:	C20H10
Prerequisite:	*Maintenance and Light Repair I* (C20H09)
Credit:	2
Grade Level:	10
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Transportation courses.
Program of study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Program of Study and Sequence:	This is the second course in the *Automotive Maintenance and Light Repair* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	506, 508, 770
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-transportation-distribution-logistics.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

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Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course; this is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstrations. These include Career Pathways Showcase, Job Interview, Maintenance Light Repair, and Automotive Service Technology.

Using a Work-Based Learning (WB) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standard 1.2** | Include a safety briefing in a visit to a shop.
- **Standard 3.3, 3.10, 3.11, 3.12 |** Have a technician discuss working on suspension and steering systems.
- **Standards 4.2, 5.1 |** Have a technician discuss how they work on brakes.

Course Description

The *Maintenance and Light Repair II (MLR II)* course prepares students for entry into *Maintenance and Light Repair III*. Students study and service suspension and steering systems and brake systems. Upon completing all of the Maintenance and Light Repair courses, students may enter the automotive service industry as an Automotive Service Excellence (ASE) Certified MLR Technician.

Hours earned in the *Maintenance and Light Repair* courses may be used toward (ASE) Education Foundation standards and Tennessee Department of Education standards. ASE requires that 95% of the P-1 tasks, 80% of the P-2 tasks, and 50% of the P-3 tasks will be accomplished. These tasks are notated in these standards.

Course Standards

1. Safety

1.1 Personal Protective Equipment: **Use and inspect personal protective equipment**. Demonstrate appropriate related safety procedures.

1.2 Safe Operating Procedures: Inspect, maintain, and **employ safe operating procedures** with tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment.

1.3 Hazards: Demonstrate continuous awareness of **potential hazards** to self and others and respond appropriately.

1.4 Hazcom: Assume responsibilities under **HazCom (Hazard Communication) regulations**.

1.5 OSHA: Adhere to responsibilities, regulations, and **Occupational Safety and Health Administration (OSHA) policies** to protect coworkers and bystanders from hazards; report accidents and observe hazards; and regard emergency response procedures.

1.6 Safety Exam: **Pass a performance examination with 100% accuracy,** relating to safety issues specific to Maintenance and Light Repair.

2. Leadership, Citizenship, and Teamwork

2.1 Leadership: Cultivate positive leadership skills. **Practice and demonstrate personal leadership skills**. For example, take advantage of opportunities provided by a career and technical student organization (CTSO), such as SkillsUSA.

2.2 Problem-Solving: Assess situations, and **apply problem-solving techniques** and decision-making skills within the school, community, and workplace.

2.3 Cooperation: Participate as a **team member** in a learning environment.

2.4 Respect Others: **Respect the opinions, customs, and individual differences of others**.

2.5 Personal Interests: **Identify career interests**, strengths, and opportunities.

3. Suspension and Steering Systems

3.1 Vehicle Information: Research applicable **vehicle and service information**, vehicle service history, service precautions, and technical service bulletins. (P-1)

3.2 Supplemental Restraint System: **Disable and enable supplemental restraint system** (SRS). (P-1)

3.3 Inspection: **Inspect rack and pinion steering gear, inner tie rod ends (sockets), and bellow boots**. (P-1)

3.4 Power Steering Fluid: Determine proper power steering fluid type; **inspect fluid level and condition**. (P-1)

3.5 Flush Power Steering System: **Flush, fill, and bleed power steering system**. (P-2)

3.6 Power Steering Leaks: Inspect for **power steering fluid leakage**; determine necessary action. (P-1)

3.7 Power Steering System Drive Belt: Remove, inspect, replace, and adjust the **power steering pump drive belt**. (P-1)

3.8 Power Steering Hoses: Inspect and replace **power steering hoses and fittings.** (P-2)

3.9 Power Steering Pump Filter: **Replace the power steering pump filter**(s). (P-2)

3.10 Inspect Arms: **Inspect pitman arm, relay (centerlink/intermediate) rod, idler arm and mountings, and steering linkage damper**. (P-1)

3.11 Inspect Tie Rods: **Inspect tie rod ends (sockets), tie rod sleeves, and clamps**. (P-1)

3.12 Inspect Control Arms: **Inspect upper and lower control arms, bushings, and shafts.** (P-1)

3.13 Bumpers: Inspect and replace **rebound and jounce bumpers**. (P-1)

3.14 Inspect Track Bars: **Inspect the track bar, strut rods/radius arms, and related mounts and bushings**. (P-1)

3.15 Inspect Ball Joints: **Inspect upper and lower ball joints**, with or without wear indicators. (P-1)

3.16 Inspect Coil Springs: **Inspect suspension system coil springs** and spring insulators (silencers). (P-1)

3.17 Inspect Suspension System Bars: **Inspect suspension system torsion bars and mounts.** (P-1)

3.18 Stabilizer Bar: **Inspect and replace front stabilizer bar** (sway bar) bushings, brackets, and links. (P-1)

3.19 Inspect Strut Cartridge: **Inspect strut cartridge or assembly**. (P-1)

3.20 Inspect Strut Bearing: **Inspect front strut bearing and mount**. (P-1)

3.21 Inspect Rear Lateral Links: **Inspect rear suspension system lateral links/arms** (track bars), control (trailing) arms. (P-1)

3.22 Inspect Rear Leaf Springs: **Inspect rear suspension system leaf spring(s)**, spring insulators (silencers), shackles, brackets, bushings, center pins/bolts, and mounts. (P-1)

3.23 Shock Absorbers: Inspect, remove, and replace **shock absorbers**; inspect mounts and bushings. (P-1)

3.24 Inspect Power Steering: **Inspect electric power-assisted steering**. (P-3)

3.25 Hybrid Power Steering: Identify the **hybrid vehicle power steering system,** electrical circuits, and safety precautions. (P-2)

3.26 Power Steering Switch: Describe the function of the **power steering pressure switch**. (P-3)

3.27 Pre-alignment Inspection: Perform **pre-alignment inspection** and measure vehicle ride height; determine necessary action. (P-1)

4. Brake Systems

4.1 Vehicle Information: Research applicable **vehicle and service information**, vehicle service history, service precautions, and technical service bulletins. (P-1)

4.2 Road Test: Describe the procedure for performing a **road test to check brake system operation**, including an anti-lock brake system (ABS). (P-1)

4.3 Brake Pedal: Measure **brake pedal** height, travel, and free play, as applicable; determine necessary action. (P-1)

4.4 Master Cylinder: Check the **master cylinder** for external leaks and proper operation. (P-1)

4.5 Brake Lines and Hoses: Inspect **brake lines, flexible hoses, and fittings** for leaks, dents, kinks, rust, cracks, bulging, wear, loose fittings and supports; determine necessary action. (P-1)

4.6 Brake Fluid: **Select, handle, store, and fill brake fluids to the proper level**. (P-1)

4.7 Brake Warning Light: Identify components of the **brake warning light system**. (P-3)

4.8 Flush Brake System: **Bleed and/or flush brake system**. (P-1)

4.9 Test Brake Fluid: **Test brake fluid for contamination**. (P-1)

4.10 Brake Drums: **Remove, clean, inspect, and measure brake drum diameter**; determine necessary action. (P-1)

4.11 Refinish Brake Drums: **Refinish the brake drum** and measure the final drum diameter; compare with specifications. (P-1)

4.12 Brake Shoes: **Remove, clean, and inspect brake shoes, springs, pins, clips, levers, adjusters/self-adjusters**, other related brake hardware, and backing support plates; lubricate and reassemble. (P-1)

4.13 Inspect Wheel Cylinders: **Inspect wheel cylinders** for leaks and proper operation; remove and replace as needed (P-2)

4.14 Install Brake Drums: Pre-adjust brake shoes and parking brake; **install brake drums** or drum/hub assemblies and wheel bearings; make final checks and adjustments. (P-2)

4.15 Lug Nuts: **Install wheel and torque lug nuts.** (P-1)

4.16 Caliper Assembly: **Remove and clean caliper assembly**; inspect for leaks and damage/wear to caliper housing; determine necessary action. (P-1)

4.17 Caliper Mounting: Clean and inspect **caliper mounting and slides/pins** for proper operation, wear, and damage; determine necessary action. (P-1)

4.18 Brake Pads: **Remove, inspect, and replace pads and retaining hardware**; determine necessary action. (P-1)

4.19 Lubricate and Reinstall: **Lubricate and reinstall caliper, pads, and related hardware; seat pads and inspect for leaks.** (P-1)

4.20 Inspect Rotors: **Clean and inspect the rotor**, measure rotor thickness, thickness variation, and lateral runout; determine necessary action. (P-1)

4.21 Rotors: **Remove and reinstall the rotor**. (P-1)

4.22 Refinish Rotor on the Vehicle: **Refinish rotor on the vehicle**; measure final rotor thickness and compare with specification (P-1)

4.23 Refinish Rotor off the Vehicle: **Refinish rotor off the vehicle**; measure final rotor thickness and compare with specifications. (P-1)

4.24 Caliper Piston: **Retract and readjust the caliper piston** on an integral parking brake system. (P-3)

4.25 Brake Pad Indicator: Check **brake pad wear indicator**; determine necessary action. (P-2)

4.26 Brake Pad Break-in: **Describe the importance of operating the vehicle to burnish/break in** replacement brake pads according to the manufacturer's recommendations. (P-1)

5. Related Vehicle Brake Systems

5.1 Brake Pedal Travel: **Check brake pedal travel,** with and without, the engine running to verify proper power boost operation. (P-2)

5.2 Vacuum Supply: **Check the vacuum supply (manifold or auxiliary pump) to vacuum-type power booster**. (P-1)

5.3 Wheel Bearings: **Remove, clean, inspect, repack, and install wheel bearings**; replace seals; install hub and adjust bearings. (P-1)

5.4 Parking Brake Cables: **Check parking brake cables** and components for wear, binding, and corrosion; clean lubricate, adjust, or replace as needed. (P-2)

5.5 Parking Brake Operation: **Check parking brake operation** and parking brake indicator light system operation; determine necessary action. (P-1)

5.6 Brake Lights: **Check the operation of the brake stop light system**. (P-1)

5.7 Wheel Bearing and Race: **Replace wheel bearing and race**. (P-2)

5.8 Traction Control: Identify **traction control/vehicle stability control system** components. (P-3)

5.9 Regenerative Brakes: **Describe the operation of a regenerative braking system**. (P-3)

6. Team Project

6.1 Team Project with Data Analysis: As a team, **identify a problem** related to the program of study as a whole. **Research and utilize the Engineering Design Process to design a solution**. Document the following steps in an **engineering design notebook** for inclusion in the program portfolio. When possible, connect the problem to an existing SkillsUSA event.

a. **Problem Identification**: Brainstorm specific problems and challenges with the program of study. Conduct basic research to understand the scope and implications of the identified problem. Identfy one problem as a focus area.

b. **Research and Analysis**: Conduct in-depth research on chosen topics related to the problem. Locate and analyze a dataset related to the problem.
c. **Review the Stages of the Engineering Design Process**: Define the problem, research, brainstorm solutions, develop prototypes, test and evlauate, and iterate. Consider constraints, such as cost, efficiency, and environmental impact during the design process.
d. **Project Implementation**: Assign specific roles within the design teams (e.g., project manager, researcher, designer, tester). Design a solution tailored to address the identified problem or scenario. Document progress through design journals, sketches, diagrams, and digital presentations. (Note: Prototype is optional in the Year 2 course.)
e. **Presentation and Reflection**: Showcase the problem and solution to the class. Share the data that was analyzed and how it affected the solution. Discuss the design process and challenges. As a class, critically evaluate the effectiveness and feasibility of the solutions and propose potential improvements.

Teacher Resources

The following resources are available to assist teachers of this course.

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Maintenance and Light Repair III (MLR III)

Primary Career Cluster:	Transportation
Course Contact:	CTE.Standards@tn.gov
Course Code:	C20H11
Prerequisite:	*Maintenance and Light Repair II* (C20H10)
Credit:	1
Grade Level:	11
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Transportation courses.
Program of study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the third course in the *Automotive Maintenance and Light Repair* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	506, 508, 770
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-transportation-distribution-logistics.html Best for All Central: https://bestforall.tnedu.gov/

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- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstrations. These include Career Pathways Showcase, Job Interview, Maintenance Light Repair, and Automotive Service Technology.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standard 1.2** | Include a safety briefing in a visit to a shop.
- **Standard 3.2, 3.5, 3.9** | Have a technician discuss diagnosing and repairing electrical systems.
- **Standard 4.1, 4.4** | Have a technician discuss batteries.
- **Standard 5.4, 5.9** | Have a technician discuss vehicle starting and charging systems.
- **Standard 6.2** | Visit a shop that allows the students to help repair a lighting system or accessory.

Course Description

The *Maintenance and Light Repair III (MLR III)* course prepares students for entry into *Maintenance and Light Repair IV*. Students study automotive general electrical systems, starting and charging systems, batteries, lighting, and electrical accessories. Upon completing all of the *Maintenance and Light Repair* courses, students may enter the automotive service industry as an Automotive Service Excellence(ASE) Certified MLR Technician.

Hours earned in the *Maintenance and Light Repair* courses may be used toward meeting ASE Education Foundation standards and Tennessee Department of Education standards. ASE requires

that 95% of the P-1 tasks, 80% of the P-2 tasks, and 50% of the P-3 tasks will be accomplished. These tasks are notated in these standards.

Course Standards

1. Safety

1.1 Personal Protective Equipment: **Use and inspect personal protective equipment**. Demonstrate appropriate related safety procedures.

1.2 Safe Operating Procedures: Inspect, maintain, and **employ safe operating procedures** with tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment.

1.3 Hazards: Demonstrate continuous awareness of **potential hazards** to self and others and respond appropriately.

1.4 Hazcom: Assume responsibilities under **HazCom (Hazard Communication) regulations**.

1.5 OSHA: Adhere to responsibilities, regulations, and **Occupational Safety and Health Administration (OSHA) policies** to protect coworkers and bystanders from hazards, report accidents and observe hazards, and regard emergency response procedures.

1.6 Safety Exam: **Pass a performance examination with 100% accuracy,** relating to safety issues specific to Maintenance and Light Repair.

2. Leadership, Citizenship, and Teamwork

2.1 Leadership: Cultivate positive leadership skills. **Practice and demonstrate personal leadership skills**. For example, take advantage of opportunities provided by a career and technical student organization (CTSO), such as SkillsUSA.

2.2 Problem-Solving: Assess situations, and **apply problem-solving techniques** and decision-making skills within the school, community, and workplace.

2.3 Cooperation: Participate as a **team member** in a learning environment.

2.4 Respect Others: **Respect the opinions, customs, and individual differences of others.**

2.5 Personal Interests: **Identify career interests**, strengths, and opportunities.

3. Automotive Electrical Systems

3.1 Vehicle Information: Research applicable **vehicle and service information**, vehicle service history, service precautions, and technical service bulletins. (P-1)

3.2 Principles of Electricity: Demonstrate knowledge of electrical/electronic series, parallel, and series-parallel circuits using **principles of electricity** (Ohm's Law). (P-1)

3.3 Wiring Diagrams: **Use wiring diagrams to trace electrical/electronic circuits**. (P-1)

3.4 Multimeter: Demonstrate the **proper use of a digital multimeter** (DMM) when measuring source voltage, voltage drop (including grounds), current flow, and resistance. (P-1)

3.5 Electrical/Electronic Circuits: Demonstrate knowledge of the causes and effects of shorts, grounds, opens, and resistance **problems in electrical/electronic circuits**. (P-2)

3.6 Test Light: **Check the operation of electrical circuits with a test light**. (P-2)

3.7 Jumper Wires: **Check the operation of electrical circuits with fused jumper wires**. (P-2)

3.8 Battery Drain: Measure key-off **battery drain** (parasitic draw). (P-1)

3.9 Inspections: **Inspect and test fusible links, circuit breakers, and fuses;** determine necessary action. (P-1)

3.10 Soldering: Perform **solder repair** of electrical wiring. (P-1)

3.11 Connectors: Replace **electrical connectors and terminal ends**. (P-1)

4. Vehicle Batteries

4.1 Battery Test: **Perform battery state-of-charge test**; determine necessary action. (P-1)

4.2 Battery Capacity: Confirm proper **battery capacity for vehicle application**; perform battery capacity test; determine necessary action. (P-1)

4.3 Electronic Memory: **Maintain or restore electronic memory functions**. (P-1)

4.4 Battery Maintenance: **Inspect and clean battery; fill battery cells; check battery cables, connectors, clamps, and hold-downs.** (P-1)

4.5 Charge Battery: **Perform slow/fast battery charge** according to manufacturer's recommendations. (P-1)

4.6 Jump-Start Vehicle: **Jump-start the vehicle using jumper cables** and a booster battery or auxiliary power supply. (P-1)

4.7 High Voltage: Identify **high-voltage circuits of electric or hybrid electric vehicles** and related safety precautions. (P-3)

4.8 Electronic Systems: **Identify electronic modules, security systems, radios,** and other accessories that require reinitialization or code entry after reconnecting the vehicle battery. (P-1)

4.9 Hybrid Batteries: **Identify hybrid vehicle auxiliary (12v) battery service**, repair, and test procedures. (P-3)

5. Vehicle Starting and Charging Systems

5.1 Draw Test: Perform **starter current draw test**; determine necessary action. (P-1)

5.2 Starter Drop Test: Perform **starter circuit voltage drop tests**; determine necessary action. (P-1)

5.3 Relays and Solenoids: Inspect and test **starter relays and solenoids**; determine necessary action. (P-2)

5.4 Starter: **Remove and install a starter in a vehicle**. (P-1)

5.5 Switches and Connectors: **Inspect and test switches, connectors, and wires** of starter control circuits; determine necessary action. (P-2)

5.6 Output Test: Perform **charging system output test**; determine necessary action. (P-1)

5.7 Belts: **Inspect, adjust, or replace generator (alternator) drive belts**; check pulleys and tensioners for wear; check pulley and belt alignment. (P-1)

5.8 Alternator: **Remove, inspect, and re-install the generator (alternator).** (P-2)

5.9 Charging Drop Test: **Perform charging circuit voltage drop tests**; determine necessary action. (P-1)

6. Vehicle Lighting and Accessory Systems

6.1 Airbag: **Disable and enable the airbag system for vehicle service**; verify indicator lamp operation. (P-1)

6.2 Lights: **Inspect interior and exterior lamps and sockets, including headlights and auxiliary lights** (e.g., fog lights/driving lights); replace as needed. (P-1)

6.3 Headlights: **Aim headlights**. (P-2)

6.4 Headlight Safety: Identify system voltage and safety precautions associated with **high-intensity discharge headlights.** (P-2)

6.5 Door Panel: **Remove and reinstall the door panel**. (P-1)

6.6 Keyless Systems: Describe the operation of **keyless entry/remote-start systems**. (P-3)

6.7 Instrument Panel: Verify operation of **instrument panel gauges and warning/indicator lights**; reset maintenance indicators. (P-1)

6.8 Wipers: Verify **windshield wiper and washer operation**; replace wiper blades. (P-1)

Teacher Resources

The following resources are available to assist teachers of this course.

- *Development Guidance: Classroom Activities*, Center on Education and Work, Madison, Wisconsin
- *Instructor Guide,* Automotive Service Excellence (ASE), http://aseinstructorguide.com/
- *Introduction to Transportation Service Technology*, Service Series, Curriculum and Instructional Material Center (CIMC), Oklahoma Department of Vocational and Technical Education
- *Module 1 Introduction to Transportation Technology*, Instructional Materials Laboratory (IML), University of Missouri
- *Today's Technician Basic Transportation Service & Systems*, Webster & Owens, Delmar/ITP
- 2022 Automotive Standards, Automotive Service Excellence (ASE), https://www.aseeducationfoundation.org/resources
- General Motors Diagnostic Plan
- Ford Motor Company Diagnostic Plan
- Harley Davidson Institute

Maintenance and Light Repair IV (MLR IV)

Primary Career Cluster:	Transportation
Course Contact:	CTE.Standards@tn.gov
Course Code:	C20H12
Prerequisite:	*Maintenance and Light Repair III* (C20H11)
Credit:	2
Grade Level:	12
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Transportation courses.
Program of study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Program of Study and Sequence:	This is the fourth course in the *Automotive Maintenance and Light Repair* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	506, 508, 770
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-transportation-distribution-logistics.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. Note this is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstrations. These include Career Pathways Showcase, Job Interview, Maintenance Light Repair, and Automotive Service Technology.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standard 1.2** | Include a safety briefing in a visit to a shop.
- **Standard 3.3, 3.7** | Have a technician discuss issues related to air-conditioning systems.
- **Standard 4.2, 4.8** | Have a technician discuss engine performance systems.
- **Standards 5.4, 5.5, 6.4, 6.6** | Have a technician discuss transmissions.
- **Standard 7.1, 7.5** | Have a manager discuss workplace etiquette.

Course Description

The *Maintenance and Light Repair IV (MLR IV)* course prepares students for entry into the automotive workforce or postsecondary training. Students study and service automotive HVAC systems, engine performance systems, automatic and manual transmission/transaxle systems, and practice workplace soft skills. Upon completing all of the *Maintenance and Light Repair* courses, students may enter the automotive service industry as an Automotive Service Excellence (ASE) Certified MLR Technician.

Hours earned in the *Maintenance and Light Repair* courses may be used toward meeting ASE Education Foundation standards and Tennessee Department of Education standards. ASE requires that 95% of the P-1 tasks, 80% of the P-2 tasks, and 50% of the P-3 tasks will be accomplished. These tasks are notated in these standards.

Course Standards

1. Safety

1.1 Personal Protective Equipment: **Use and inspect personal protective equipment**. Demonstrate appropriate related safety procedures.

1.2 Safe Operating Procedures: Inspect, maintain, and **employ safe operating procedures** with tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment.

1.3 Hazards: Demonstrate continuous awareness of **potential hazards** to self and others and respond appropriately.

1.4 Hazcom: Assume responsibilities under **HazCom (Hazard Communication) regulations**.

1.5 OSHA: Adhere to responsibilities, regulations, and **Occupational Safety & Health Administration (OSHA) policies** to protect coworkers and bystanders from hazards, report accidents and observe hazards; and regarding emergency response procedures.

1.6 Safety Exam: **Pass a performance examination with 100% accuracy,** relating to safety issues specific to Maintenance and Light Repair.

2. Leadership, Citizenship, and Teamwork

2.1 Leadership: Cultivate positive leadership skills. **Practice and demonstrate personal leadership skills.** For example, take advantage of opportunities provided by a career and technical student organization (CTSO), such as SkillsUSA.

2.2 Problem-Solving: Assess situations, and **apply problem-solving techniques** and decision-making skills within the school, community, and workplace.

2.3 Cooperation: Participate as a **team member** in a learning environment.

2.4 Respect Others: **Respect the opinions, customs, and individual differences of others.**

2.5 Personal Interests: **Identify career interests**, strengths, and opportunities.

3. Heating and A/C systems

3.1 Vehicle Information: Research applicable **vehicle and service information**, vehicle service history, service precautions, and technical service bulletins. (P-1)

3.2 Components: Identify the **vehicle's A/C components**. (P-1)

3.3 A/C System: **Inspect and replace A/C compressor drive belts, pulleys, and tensioners**; determine necessary action. (P-1)

3.4 Hybrid A/C System: Identify **hybrid vehicle A/C system** electrical circuits and the service/safety precautions. (P-2)

3.5 Condenser: **Inspect the A/C condenser for airflow restrictions**; determine necessary action. (P-1)

3.6 Hoses: Inspect engine **cooling and heater systems hoses**; perform necessary action. (P-1)

3.7 Air Flow: **Inspect A/C-heater ducts, doors, hoses, cabin filters, and outlets**; perform necessary action. (P-1)

3.8 Odors: Identify the source of **A/C system odors**. (P-2)

4. Engine Performance Systems

4.1 Vehicle Information: Research applicable **vehicle and service information**, vehicle service history, service precautions, and technical service bulletins. (P-1)

4.2 Pressure Tests: Perform engine absolute (vacuum/boost) **manifold pressure tests**; determine necessary action. (P-1)

4.3 Power Balance Test: Perform **cylinder power balance test**; determine necessary action. (P-2)

4.4 Cranking and Compression Tests: Perform **cylinder cranking and running compression tests**; determine necessary action. (P-1)

4.5 Cylinder Leakage Test: Perform **cylinder leakage test**; determine necessary action. (P-1)

4.6 Temperature: Verify **engine operating temperature**. (P-1)

4.7 Spark Plugs: Remove and replace **spark plugs**; inspect secondary ignition components for wear and damage. (P-1)

4.8 Trouble Codes: Retrieve and record **diagnostic trouble codes**, OBD monitor status, and freeze frame data; clear codes when applicable. (P-1)

4.9 OBDII Monitors: Describe the importance of operating all **OBDII monitors** for repair verification. (P-1)

4.10 Fuel Filters: **Replace fuel filter(s).** (P-1)

4.11 Air Filters: Inspect, service, or replace **air filters, filter housings, and intake ductwork**. (P-1)

4.12 Exhaust System: Inspect the integrity of the **exhaust manifold, exhaust pipes, muffler(s), catalytic converter(s), resonator(s), tail pipe(s), and heat shields**; determine necessary action. (P-1)

4.13 Exhaust Brackets: Inspect the condition of **exhaust system hangers, brackets, clamps, and heat shields**; repair or replace as needed. (P-1)

4.14 Diesel Exhaust Fluid: Check and refill **diesel exhaust fluid** (DEF). (P-3)

4.15 PCV Valve: Inspect, test, and service **positive crankcase ventilation (PCV) filter/breather cap, valve,** tubes, orifices, and hoses; perform necessary action. (P-2)

4.16 Timing Belt: Remove and replace the **timing belt**; verify correct camshaft timing. (P-1)

5. Automatic Transmissions and Transaxles

5.1 Vehicle Information: Research applicable **vehicle and service information**, fluid type, vehicle service history, service precautions, and technical service bulletins. (P-1)

5.2 Fluid Check With Dip-stick: **Check the fluid level in a transmission or a transaxle equipped with a dip-stick**. (P-1)

5.3 Fluid Check Without Dip-stick: **Check fluid level in a transmission or a transaxle not equipped with a dip-stick.** (P-1)

5.4 Transmission Fluid: Check **transmission fluid condition**; check for leaks. (P-2)

5.5 Linkage and Switches: **Inspect, adjust, and replace external manual valve shift linkage, transmission range sensor/switch, and park/neutral position switch**. (P-2)

5.6 Leaks: **Inspect for leakage at external seals, gaskets, and bushings**. (P-2)

5.7 Mounts: **Inspect power train mounts**. (P-2)

5.8 Fluid and Filters: **Drain and replace fluid and filter(s).** (P-1)

5.9 Continuously Variable Transmission: Describe the operational characteristics of a **continuously variable transmission (CVT).** (P-3)

5.10 Hybrid Drive Train: Describe the operational characteristics of a **hybrid vehicle drive train**. (P-3)

6. Manual Transmissions and Transaxles

6.1 Vehicle Information: Research applicable **vehicle and service information**, fluid type, vehicle service history, service precautions, and technical service bulletins. (P-1)

6.2 Drain and Refill Fluid: **Drain and refill manual transmission/transaxle and final drive unit**. (P-1)

6.3 Fluid: **Check fluid condition**; check for leaks. (P-2)

6.4 Clutch Master Cylinder: **Check and adjust the clutch master cylinder** fluid level. (P-1)

6.5 Leaks: **Check for system leaks**. (P-1)

6.6 Electronically-Controlled Manual Transmission: Describe the operational characteristics of an **electronically-controlled manual transmission/transaxle**. (P-1)

6.7 Front Wheel Drive: Inspect, remove, and replace **front wheel drive (FWD) bearings, hubs, and seals.** (P-2)

6.8 Shafts and Boots: Inspect, service, and replace **shafts, yokes, boots, and universal/CV joints**. (P-2)

6.9 Inspect Differential Housing: Clean and inspect **differential housing**; check for leaks; inspect housing vent. (P-2)

6.10 Differential Fluid: Check and adjust **differential housing fluid** level. (P-1)

6.11 Differential Housing: Drain and refill **differential housing.** (P-1)

6.12 Drive Axle Wheel Studs: Inspect and replace **drive axle wheel studs**. (P-2)

6.13 Front Wheel Bearings: Inspect **front-wheel bearings** and locking hubs. (P-3)

6.14 Drive Assembly Seals: Check for leaks at **drive assembly seals**; check vents; check lube level. (P-2)

7. Workplace Etiquette, Communication Skills, and Professional Appearance

7.1 Communication: Identify and exhibit appropriate **oral and written communications** on a personal and professional level.

7.2 Leadership: Identify the need for leadership and describe **leadership qualities**, such as honesty and integrity, fairness, responsible behavior, ethical work habits, passion for goals, positive attitude, enthusiasm, and empathy.

7.3 Job Application Prep: **Perform mock interviews, and prepare resume, job applications, cover letters, and portfolios.**

7.4 Legal Issues: Identify **legal issues of employment**, including sexual harassment, discrimination, violence, and unemployment.

7.5 Stress: Analyze ways of **handling stress in the workplace.**

Teacher Resources

The following resources are available to assist teachers of this course.

- *Development Guidance: Classroom Activities,* Center on Education and Work, Madison, Wisconsin
- *Instructor Guide,* Automotive Service Excellence (ASE), http://aseinstructorguide.com/
- Introduction to Transportation Service Technology, Service Series, Curriculum and Instructional Material Center (CIMC), Oklahoma Department of Vocational and Technical Education
- Module 1 Introduction to Transportation Technology, Instructional Materials Laboratory (IML), University of Missouri
- 2022 Automotive Standards, Automotive Service Excellence (ASE), https://www.aseeducationfoundation.org/resources

Introduction to Collision Repair

Primary Career Cluster:	Transportation
Course Contact:	CTE.Standards@tn.gov
Course Code:	C20H20
Prerequisite:	None
Credit:	1
Grade Level:	9
Elective Focus-Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Transportation courses.
Program of study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the first course in the *Automotive Collision Repair* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	507, 771
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-transportation-distribution-logistics.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. Note this is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstrations. These include Career Pathways Showcase, Job Interview, Collision Damage Appraisal, Collision Repair Technology, and Automotive Refinishing Technology.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standard 1.1** | Include a safety briefing in a visit to an industry partner/job site.
- **Standards 3.1-3.2 |** Have a technician talk with students about their careers.
- **Standard 4.1 |** Have a shop manager discuss how their collision repair operation works.
- **Standards 6.1-7.2** | Visit a shop to see the tools and materials used.
- **Standards 8.1-10.1** | Visit a shop and have a technician discuss the preparation process.

Course Description

Introduction to Collision Repair is a foundational course in the *Automotive Collision Repair* program of study for students interested in learning more about automotive collision repair technician careers. Upon completion of this course, proficient students will be able to identify and explain the basic steps in the collision repair process, emphasizing the tools, equipment, and materials used. They will be able to describe the major parts of an automobile body and safely perform basic procedures in preparing automotive panels for repair, applying body filling, and preparing surfaces for painting. Standards in this course include career investigation of the opportunities in automotive collision repair as well as an overview of the history of automobile design and construction. Students completing the *Automotive Collision Repair* program of study will be eligible to take the examination for Automotive Student Excellence (ASE) Student Certification in Collision Repair. Some tasks are

assigned a "High Priority (HP)" designation. ASE-accredited programs must include at least 95% of the HP-I (Individual) tasks and 90% of the HP-G (Group) tasks in the curriculum.

Course Standards

1. Safety

1.1 Safety: Comply with personal and environmental **safety practices** associated with clothing and the use of gloves; respiratory protection; eye protection; hearing protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations. Identify vehicle manufacturer's SRS (supplemental restraint system) types, locations, and recommended procedures before inspecting or replacing components.

a. Use and inspect **personal protective equipment** every time equipment is used.
b. Inspect, maintain, and employ **safe operating procedures** with tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment.
c. Assume responsibilities under HazCom (Hazard Communication) regulations.
d. Adhere to responsibilities, regulations, and Occupational Safety and Health Administration (OSHA) policies regarding the reporting of accidents and observed hazards and regarding emergency response procedures.
e. Maintain a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.
f. Utilize SDSs (safety data sheets) and identify the health hazards associated with hazardous material.

2. History of Automobiles

2.1 History of Automobiles: Explain the significant time periods in the development of automobile design and construction, emphasizing the **changing collision repair methods**. Analyze the impact of a particular event or time period on current **practices in the collision repair industry**.

3. Career Investigation

3.1 Career Plan: Summarize the **essential knowledge and skills** required for collision repair technicians. Identify and analyze areas of specialization within the Collision Repair field such as metal technician, structural technician, refinish technician, and detailing technician. Explain the aptitudes and training needed for a collision repair technician career. Devise a **tentative career plan** to reach employment goals.

3.2 Job Opportunities: Compile and analyze real-time and projected **labor market data** from public sources such as the U.S. Bureau of Labor Statistics to investigate local and regional

occupational opportunities and trends in the field of collision repair. Synthesize collected data to explain **education requirements, job availability, salaries, and benefits**.

3.3 Career and Technical Student Organization Introduction: **Introduce the program's aligned CTSO**, SkillsUSA, through an interactive activity, such as a classroom competition.

4. Overview of Collision Repair Operations

4.1 Overview: Research collision repair processes described in textbooks, repair center websites, or by interviewing technicians. Describe the **major steps involved in the collision repair process**, including estimating, disassembling, performing repairs, refinishing, reassembling, detailing, and final inspection. Discriminate between the different types of repair work such as metal work, structural repairs, mechanical and electrical repairs, and refinishing.

5. Vehicle Construction

5.1 Vehicle Identification: Utilize appropriate terminology to classify and describe **vehicles** based on vehicle size, roof design, drive system type, and engine location. Compare and contrast the **major types of body frames** (i.e., body-over-frame, unibody, and space frame). Describe the **major structural parts, sections, and assemblies** of each type of body frame.

5.2 Vehicle Components: Identify and describe the **major parts and components** that make up an automobile body, analyzing the **purpose** of and interrelationships among each component and explaining the sequence in which each is put together in assembly.

6. Tools and Equipment

6.1 Identify Tools and Equipment: Accurately identify a wide range of hand tools, power tools, and equipment used in the collision repair industry. **Hand tools** should include wrenches, sockets, screwdrivers, pliers, files, holding tools, punches, chisels, and hammers in metric and/or Society of Automotive Engineers (SAE) sizes where appropriate. **Power tools** should include air tools, grinders, polishers, blasters, and spray guns. **Equipment** should include spray booths, paint drying equipment, straightening systems, and lifts.

6.2 Use of Tools and Equipment: Assess a variety of situations requiring the use of hand tools, power tools, and equipment. **Select the proper tool**, critique the readiness of the tool, **use the tool** to accomplish the desired task, clean the tool, and then return the tool to its proper storage according to the correct size and nomenclature. For example, demonstrate the ability to safely use an air ratchet to remove hood hinge bolts.

6.3 Measurement Devices: Use physical **measurement devices** typically employed in collision repair to complete accurate field measurements. Determine the appropriate units and record **accurate measurements** of lengths, angles, pressure, volume, and other

measurements. Tools should include but are not limited to fractional rule, metric rule, measuring tape, dial caliper, micrometer, dial indicators, pressure gauges, and mixing cups.

6.4 Mathematics: Apply **mathematical concepts to solve collision repair problems**, distinguishing which principles apply to a given automotive problem. Concepts should include, but are not limited to the following:

a. operating with whole numbers, fractions, and decimals;
b. performing conversions between fractions, decimals, and percent. For example, convert a decimal to a fraction to prepare a unit for measurement on a fractional scale to the precision of 1/16 of an inch;
c. working with units such as feet, inches, meters, centimeters, and millimeters, and determining appropriate units for a given repair task. For example, convert fractions of an inch into millimeters to determine the appropriate size metric wrench to use to loosen a bolt; and
d. performing proportionate reasoning to estimate quantities.

7. Collision Repair Materials

7.1 Use Fasteners: Distinguish between the **various types of fasteners** commonly used in vehicle construction, such as bolts, nuts, washers, screws, nonthreaded fasteners, and adhesives, by creating a visual display outlining the properties and uses of each type. Define torque and describe the procedures for applying the **appropriate torque** to tighten bolts. Demonstrate the ability to accurately **remove, reinstall, and select** the appropriate fastener in a variety of situations. For example, consult torque specifications to determine the torque value for a given size and grade of the bolt, and perform proper tightening sequences to secure bolts.

7.2 Materials: Compare and contrast the properties and uses of basic **materials employed in collision repair processes**, such as body fillers, putty, mashing materials, abrasives, sandpapers, primers, paint types, drying and curing materials, and sealers. Describe and demonstrate common procedures used by collision repair centers to clean and properly dispose of materials and supplies.

8. Preparation of Non-Structural Body Components

8.1 Prepare Non-Structural Body Components: **Apply the basic steps necessary to prepare non-structural body components for repair.**

a. Review damage reports and **analyze damage** to determine appropriate methods for overall repair; develop and document a **repair plan**. (HP-I)
b. Inspect, remove, label, store, and reinstall exterior trim and moldings. (HP-I)
c. Protect panels, glass, interior parts, and other vehicles adjacent to the repair area. (HP-I)
d. Soap and water wash the entire vehicle; complete the pre-repair inspection checklist. (HP-I)

8.2 Damage Assessment and Repair Plan Project: Understand the concept of **damage assessment and the role of repair plans** in guiding repair processes.

a. Review sample damage reports and analyze the extent of damage to non-structural body components.
b. Develop repair plans that outline appropriate methods for overall repair, including steps for addressing specific types of damage.
c. Document the process and findings, including observations and thought processes, with other artifacts for inclusion in a program portfolio.

9. Metal Finishing and Body Filling of Non-Structural Body Components

9.1 Metal Finishing and Body Filling: Demonstrate the basic steps necessary to properly repair **surface irregularities on a damaged body panel**. Apply the appropriate tools, equipment, and procedures to safely perform **panel repairs**.

a. Remove paint from the damaged area of the body panel. (HP-I)
b. Locate and repair surface irregularities on a damaged body panel. (HP-I)
c. Heat shrink stretched panel areas to proper contour. (HP-I)
d. Identify different types of body fillers. (HP-G)
e. Prepare and apply body filler. (HP-I)
f. Rough sand body filler to contour; finish sand. (HP-I)

10. Surface Preparation for Painting and Refinishing

10.1 Prepare for Painting and Refinishing: Demonstrate the basic steps necessary to **prepare a surface for painting**. Apply the appropriate tools, equipment, and procedures to safely prepare a surface for painting.

a. Mix primer, primer-surfacer, or primer-sealer. (HP-I)
b. Apply primer onto the surface of the repaired area. (HP-I)
c. Block sand area to which primer-surfacer has been applied. (HP-I)
d. Dry sand area to which finishing filler has been applied. (HP-I)
e. Clean the area to be refinished using a final cleaning solution. (HP-I)

10. Data Analysis and Artificial Intelligence

11.1 Data Analysis in Transportation: **Research the use of data** in the transportation career fields. Include data that is generated internally by businesses, and externally by local communities, state, and the nation. Explore examples of how data is used, including the following:

a. customer/client use of products and services in collision repair;
b. demographics of end users of collision repair facilities;
c. community, state, and national statistics related to collision repair; and
d. data that must be reported to another activity that impacts collision repair.

11.2 Ethical Artificial Intelligence (AI): **Explore the ethical implications of AI usage** through interactive discussions and case studies, learning to identify bias, ensure fairness, and protect privacy in AI systems. **Develop** critical thinking **skills to evaluate the societal impact of AI technologies**, while fostering a sense of responsibility and ethical decision-making in the use of AI tools.

Standards Alignment Notes

*References to other standards include:

- Automotive Service Excellence (ASE) Education Foundation standards for Collision Repair and Refinish.
- P21: Partnership for 21st Century Skills
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

Collision Repair: Non-Structural

Primary Career Cluster:	Transportation
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C20H13
Prerequisite(s):	*Introduction to Collision Repair* (C20H20)
Credit:	1 – 3 (See Recommended Credit below)
Grade Level:	10 – 12
Elective Focus-Graduation Requirements:	This course satisfies up to three credits of three credits required for an elective focus when taken in conjunction with other Transportation courses.
POS Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This course is the second course in the *Automotive Collision Repair* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	507, 771
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-transportation-distribution-logistics.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career and technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. Note this is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstrations. These include Career Pathways Showcase, Job Interview, Collision Damage Appraisal, Collision Repair Technology, and Automotive Refinishing Technology.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standard 1.1** | Include a safety briefing in a visit to an industry partner/job site.
- **Standards 2.1-2.2 |** Visit a local company and participate in the preparation done by a technician in the shop.
- **Standards 3.1-3.3 |** Have the students work with a technician on a real project.
- **Standards 4.1-6.5** | Have the students complete a project that is supervised or evaluated by a manager at a local company.
- **Standard 7.1** | Discuss plastics and adhesives with the employee responsible for plastics.

Course Description

Collision Repair: Non-Structural is for students who wish to obtain in-depth knowledge and skills in repair procedures for non-structural repairs in preparation for postsecondary training and careers as collision repair technicians. Upon completion of this course, proficient students will be able to analyze non-structural collision damage and write and revise repair plans. Students will read and interpret technical texts to determine, understand, and safely perform appropriate repair techniques and procedures. Standards in this course include preparing vehicles for repair, removing and replacing panels and body components, metal finishing, body filling, removing, and replacing moveable glass and hardware, metal welding and cutting, and repair of plastics. Students

completing the *Automotive Collision Repair* program of study will be eligible to take the examination for Automotive Student Excellence (ASE) Student Certification in Collision Repair and the examination for ASE Professional Certification in Non-Structural Analysis and Damage Repair (B3). Some tasks are assigned a "High Priority (HP)" designation. ASE-accredited programs must include at least 95% of the HP-I (Individual) tasks and 90% of the HP-G (Group) tasks in the curriculum.

Recommended Credits

If all standards in the course are covered, the course is recommended for three credits. If one or two credits are offered, the following options are recommended.

1 Credit Option

Content	Standards
Safety	1.1- all
Preparation	2.1- all 2.2- e, f, g
Outer Body Panel Repairs, Replacements, and Adjustments	3.1- all 3.25- b
Metal Welding and Cutting	6.1- f, g, h, 6.2- a 6.3- a, b 6.4- b, c 6.5- b
Plastics and Adhesives	7.1- a, b
New Trends and Data Analysis	8.1 – 8.3

2 Credit Option

Content	Standards
Safety	1.1- all
Preparation	2.1- all 3.2- all
Outer Body Panel Repairs, Replacements, and Adjustments	3.1- all 3.2- all 3.3- c, g
Metal Finishing and Body Filling	4.1- a, b, c, f, g, h, i, j
Moveable Glass and Hardware	5.1- b
Metal Welding and Cutting	6.1- all 6.2- all 6.3- a, b 6.4- all 6.5- all
Plastics and Adhesives	7.1- all
New Trends and Data Analysis	8.1- 8.3

Course Standards

1. Safety

1.1 Safety: Comply with **personal and environmental safety practices** associated with clothing and the use of gloves; respiratory protection; eye protection; hearing protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations. Identify the vehicle manufacturer's SRS types, locations, and recommended procedures before inspecting or replacing components.

a. Use and inspect personal protective equipment every time equipment is used.

b. Inspect, maintain, and employ safe operating procedures with tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment.
c. Assume responsibilities under HazCom (Hazard Communication) regulations.
d. Adhere to responsibilities, regulations, and Occupational Safety and Health Administration (OSHA) policies regarding reporting accidents, observed hazards, and emergency response procedures.
e. Utilize SDSs (safety data sheets), and identify the health hazards associated with hazardous material.

2. Preparation

2.1 Damages and Plan: Read and interpret a **damage report** and observe **damages**, synthesizing information from both text and observation to create a basic repair plan for a damaged automobile. Create a written overview of the steps necessary to repair the vehicle.
a. Review damage reports and analyze damages to determine appropriate methods for overall repair; develop and document a **repair plan**. (HP-I)

2.2 Prepare a Vehicle: Describe and demonstrate the **steps necessary to prepare a vehicle** for non-structural repair. Create a list of tools, equipment, and materials needed for each step of preparation. Describe the responsibilities and procedures of the repair technician, emphasizing safety procedures in each of the following.
a. Inspect, remove, label, store, and reinstall exterior trim and moldings. (HP-I)
b. Inspect, remove, label, store, and reinstall interior trim and components. (HP-I)
c. Inspect, remove, label, store, and reinstall body panels and components that may interfere with or be damaged during repair. (HP-I)
d. Inspect, remove, label, store, and reinstall vehicle mechanical and electrical components that may interfere with or be damaged during repair. (HP-G)
e. Protect panels, glass, interior parts, and other vehicles adjacent to the repair area. (HP-I)
f. Soap and water wash the vehicle; complete the pre-repair inspection checklist. (HP-I)
g. Prepare damaged areas using water-based and solvent-based cleaners. (HP-I)
h. Remove corrosion protection, undercoating, sealers, and other protective coatings as necessary to perform repairs.
i. Inspect, remove, and reinstall repairable plastics and other components for off-vehicle repair. (HP-I)

3. Outer Body Panel Repairs, Replacements, and Adjustments

3.1 Updated Repair Plan: Determine the direct and indirect/hidden **damage and direction of impact**. Understand various damages incurred on the vehicle. Hypothesize the direction of impact, citing evidence to justify. Use the information to investigate and report on the damage incurred in outer body panels. Review, edit, and revise the repair plan generated in standard 2.1, using technology where appropriate.
a. Determine the extent of direct and indirect/hidden damage and direction of impact; develop and document an **updated repair plan**. (HP-I)

3.2 Outer Body Panels: Distinguish among the various **panels and components of a vehicle's outer body**. Compare and contrast the tools, equipment, and procedures for inspecting, removing, replacing, and aligning each of the following. Demonstrate the proper steps in inspecting the components of a vehicle's outer body.

a. Inspect, remove, and replace bolted, bonded, and welded steel panels or panel assemblies. (HP-G)
b. Determine the extent of damage to aluminum body panels; repair or replace. (HP-G)
c. Inspect, remove, replace, and align hood, hood hinges, and hood latch. (HP-I)
d. Inspect, remove, replace, and align the deck lid, lid hinges, and lid latch. (HP-I)
e. Inspect, remove, replace, and align doors, latches, hinges, and related hardware. (HP-I)
f. Inspect, remove, replace, and align tailgates, hatches, liftgates, and sliding doors. (HP-G)
g. Inspect, remove, replace, and align bumper bars, covers, reinforcement, guards, isolators, and mounting hardware. (HP-I)
h. Inspect, remove, replace, and align fenders, and related panels. (HP-I)

3.3 Repair Outer Body Panels: Use the proper tools and procedures to **repair outer body panels**.

a. Straighten contours of damaged panels to a suitable condition for body filling or metal finishing using power tools, hand tools, and weld-on pulling attachments. (HP-I)
b. Weld damaged or torn steel body panels; repair broken welds. (HP-G)
c. Restore corrosion protection. (HP-I)
d. Replace door skins. (HP-G)
e. Restore sound deadeners and foam materials. (HP-G)
f. Perform panel bonding and weld bonding. (HP-G)
g. Diagnose and repair water leaks, dust leaks, and wind noise. (HP-G)
h. Identify one-time use fasteners. (HP-G)

4. Metal Finishing and Body Filling

4.1 Body Filling and Metal Finishing: Implement the processes, tools, and materials involved in applying **body filling and finishing metal**. Prepare materials for body filler. Apply the minor body repair processes for the damages. Complete the proper repair procedures for given body panel damages.

a. Remove paint from the damaged area of a body panel. (HP-I)
b. Locate and repair surface irregularities on a damaged body panel. (HP-I)
c. Demonstrate hammer and dolly techniques. (HP-I)
d. Heat shrink stretched panel areas to proper contour. (HP-I)
e. Cold shrink stretched panel areas to proper contour. (HP-I)
f. Prepare and apply body filler. (HP-I)
g. Identify different types of body fillers. (HP-G)
h. Rough sand body filler to contour; finish sand. (HP-I)
i. Determine the proper metal finishing techniques for aluminum. (HP-G)
j. Determine the proper application of body filler to aluminum. (HP-G)

5. Moveable Glass and Hardware

5.1 Moveable Glass and Hardware: Explain the structure, purpose, and function of **moveable glass and hardware** system components and demonstrate appropriate repairs of each.

a. Inspect, adjust, repair, or replace window regulators, run channels, glass, power mechanisms, and related controls. (HP-I)
b. Inspect, adjust, repair, remove, reinstall, or replace weather stripping. (HP-G)
c. Inspect, repair, or replace, and adjust removable power-operated roof panels and hinges, latches, guides, handles, retainer, and controls of sunroofs. (HP-G)
d. Inspect, remove, reinstall, and align the convertible top and related mechanisms. (HP-G)
e. Initialize electrical components as needed. (HP-G)

6. Metal Welding and Cutting

6.1 Welding and Cutting: Determine the tools, procedures, and welding methods used to weld and cut aluminum, high-strength steel, and other steel, noting when substrates are weldable. Describe the tools, tool settings, procedures, and methods for welding in a variety of situations. Perform basic **welding and cutting** of aluminum and steel.

a. Identify weldable and non-weldable substrates used in vehicle construction. (HP-I)
b. Weld and cut high-strength steel and other steel. (HP-I)
c. Weld and cut aluminum. (HP-G)
d. Determine the correct GMAW (MIG) welder type, electrode/wire type, diameter, and gas to be used in a specific welding situation. (HP-I)
e. Set up and adjust the GMAW (MIG) welder to "tune" for proper electrode stick out, voltage, polarity, flow rate, and wire-feed speed required for the substrate being welded. (HP-I)
f. Store, handle, and install high-pressure gas cylinders. (HP-I)
g. Determine work clamp (ground) location and attach. (HP-I)
h. Use the proper angle of the gun to the joint and direction of gun travel for the type of weld being made in the flat, horizontal, vertical, and overhead positions. (HP-I)

6.2 Preparation for Welding: Describe and demonstrate how to **prepare vehicle body components for welding**.

a. Protect adjacent panels, glass, vehicle interior, etc. from welding and cutting operations. (HP-I)
b. Protect computers and other electronic control modules during welding procedures. (HP-I)
c. Clean and prepare the metal to be welded, assure good metal fit-up, apply weld through primer, if necessary, clamp or tack as required. (HP-I)

6.3 Weld Types: Distinguish among the **various types of weld and joint types**. Emphasizing proper safety equipment and techniques, implement the appropriate tools, equipment, techniques, and procedures to perform a variety of welds.

a. Determine the joint type (butt weld with backing, lap, etc.) for the weld being made. (HP-I)

b. Determine the type of weld (continuous, stitch weld, plug, etc.) for each specific welding operation. (HP-I)
c. Perform the following welds: continuous, plug, butt weld with and without backing, fillet, etc. (HP-I)

6.4 Inspect Welds: Identify and demonstrate basic **inspection and troubleshooting** strategies appropriate for **evaluating welds**. Use the knowledge to remedy any problem with a weld.
a. Perform visual and destructive tests on each weld type. (HP-I)
b. Identify the causes of various welding defects; make necessary adjustments. (HP-I)
c. Identify the cause of contact tip burn-back and failure of wire to feed; make necessary adjustments. (HP-I)

6.5 Nonstructural Components: Perform a range of procedures used to cut and attach **nonstructural components**, noting when each method is commonly used.
a. Identify the cutting process for different substrates and locations; perform cutting operations. (HP-I)
b. Identify different methods of attaching nonstructural components (squeeze type resistant spot welds (STRSW), riveting, nonstructural adhesive, silicon bronze, etc.). (HP-G)

7. Plastics and Adhesives

7.1 Plastics: Determine the damage to **plastic components**. Identify the nature of the problem and **complete appropriate repair**. Describe the types of plastic repair procedures, emphasizing the conditions that require each type of procedure. Select the appropriate repair procedures and justify the selection.
a. Identify the types of plastics; determine repairability. (HP-I)
b. Clean and prepare the surface of plastic parts; identify the types of plastic repair procedures. (HP-I)
c. Repair rigid, semi-rigid, or flexible plastic panels. (HP-I)
d. Remove or repair damaged areas from rigid exterior composite panels. (HP-G)
e. Replace bonded rigid exterior composite body panels; straighten or align panel supports. (HP-G)

8. New Trends and Data Analysis

8.1 Hybrid: Apply Automotive Electrical Theory, **Hybrid,** and Electrical Safety realities in the collision repair work.

8.2 Driver Assist Systems: Understand how Advanced **Driver Assist Systems** and Operations impact collision repair work.

8.3 Team Project with Data Analysis: As a team, **identify a problem** related to the program of study as a whole. **Research and utilize the Engineering Design Process to design a solution**. Document the following steps in an **engineering design notebook** for inclusion in the program portfolio. When possible, connect the problem to an existing SkillsUSA event.

a. **Problem Identification**: Brainstorm specific problems and challenges with the program of study. Conduct basic research to understand the scope and implications of the identified problem. Identfy one problem as a focus area.
b. **Research and Analysis**: Conduct in-depth research on chosen topics related to the problem. Locate and analyze a dataset related to the problem.
c. **Review the Stages of the Engineering Design Process**: Define the problem, research, brainstorm solutions, develop prototypes, test and evlauate, and iterate. Consider constraints such as cost, efficiency, and environmental impact during the design process.
d. **Project Implementation**: Assign specific roles within the design teams (e.g., project manager, researcher, designer, tester). Design a solution tailored to address the identified problem or scenario. Document progress through design journals, sketches, diagrams, and digital presentations. (Note: Prototype is optional in the Year 2 course.)
e. **Presentation and Reflection**: Showcase the problem and solution to the class. Share the data that was analyzed and how it affected the solution. Discuss the design process and challenges. As a class, critically evaluate the effectiveness and feasibility of the solutions and propose potential improvements.

Standards Alignment Notes

*References to other standards include:

- ASE Education Foundation standards for Collision Repair and Refinish.
- P21: Partnership for 21st Century Skills
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

Collision Repair: Painting & Refinishing

Primary Career Cluster:	Transportation
Course Contact:	CTE.Standards@tn.gov
Course Code:	C20H14
Prerequisite(s):	*Introduction to Collision Repair* (C20H20)*, Collision Repair: Non-Structural (C20H13) (optional)*
Credit:	1-3 (See Recommended Credit below)
Grade Level:	10-12
Elective Focus - Graduation Requirement:	This course satisfies up to three credits required for an elective focus when taken in conjunction with other Transportation, Distribution, & Logistics courses.
Program of study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Program of Study and Sequence:	This is the third course in the *Automotive Collision Repair* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	507, 771
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-transportation-distribution-logistics.html Best for All Central: https://bestforall.tnedu.gov/

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Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course; note this is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstrations. These include Career Pathways Showcase, Job Interview, Collision Damage Appraisal, Collision Repair Technology, and Automotive Refinishing Technology.

Using Work-based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1-1.2** | During a visit to an industry site, have the manager talk about safety in the workplace.
- **Standards 2.1-2.2 |** Have the students work with a technician on surface preparation.
- **Standard 3.1** | Have the students work with a technician on the spray gun.
- **Standards 4.1-6.1** | Have the students complete a project that is supervised or evaluated by a manager at a local company.

Course Description

Collision Repair: Painting & Refinishing is for students who wish to obtain in-depth knowledge and skills in automotive painting and refinishing procedures in preparation for postsecondary training and careers as collision repair technicians. Upon completion of this course, proficient students will be able to develop, document, and implement refinishing plans for given vehicles. Students will read and interpret technical texts to determine, understand, and safely perform appropriate repair techniques and procedures. Standards in this course include surface preparation; spray gun and related equipment operation, paint mixing, matching, and applying; diagnosis and correction of paint defects; and final detailing. Students completing the *Automotive Collision Repair* program of study will be eligible to take the examination for Automotive Student Excellence (ASE) Student

Certification in Collision Repair and ASE Professional Certification in Painting & Refinishing (B2). Some tasks are assigned a "High Priority (HP)" designation. NATEF-accredited programs must include at least 95% of the HP-I (Individual) tasks and 90% of the HP-G (Group) tasks in the curriculum.

Recommended Credits

If all standards in the course are covered, the course is recommended for three credits. If one or two credits are offered, the following options are recommended.

1 Credit Option

Content	Standards
Safety	1.1 – all 1.2 – all
Surface Preparation	2.1 – c 2.2 – f, h, j, k, l, m, n, t, u
Spray Gun and Related Equipment Operation	3.1 – all
Paint Mixing, Matching, and Applying	4.1 – a, m, o

2 Credit Option

Content	Standards
Safety	1.1 – all 1.2 – all
Surface Preparation	2.1 – all 2.2 – a, b, c, d, e, f, h, i, j, k, l, m, n, p, q, r, t, u
Spray Gun and Related Equipment Operation	3.1 – all
Paint Mixing, Matching, and Applying	4.1 – a, b, e, h, l, m, n, o
Final Detail	6.1 – c, d, e

Course Standards

1. Safety

1.1 Safety Practices: Comply with **personal and environmental safety practices** associated with clothing and the use of gloves; respiratory protection; eye protection; hearing protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations. Identify vehicle manufacturer's SRS types, locations, and recommended procedures before inspecting or replacing components.

a. Use and inspect **personal protective equipment** every time equipment is used.
b. Inspect, maintain, and employ safe operating procedures with tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment.
c. Assume responsibilities under HazCom (Hazard Communication) regulations.
d. Adhere to responsibilities, regulations, and Occupational Safety & Health Administration (OSHA) policies regarding reporting of accidents and observed hazards, and regarding emergency response procedures.
e. Maintain a portfolio record of safety examinations and equipment examination for which the student has passed an operational checkout by the instructor.
f. Utilize SDSs (safety data sheets) and identify the health hazards associated with hazardous material.

1.2 Safety Regulations and Procedures: Locate, read, and interpret federal, state, and local regulations impacting the painting and refinishing of vehicles. Follow **regulations and procedures** to work safely around materials and equipment.

a. Identify and take necessary precautions with hazardous operations and materials according to federal, state, and local regulations. (HP-I)
b. Identify safety and personal health hazards according to OSHA guidelines and the "Right to Know Law". (HP-I)
c. Inspect spray environment and equipment to ensure compliance with federal, state, and local regulations, and for safety and cleanliness hazards. (HP-I)
d. Select and use a NIOSH-approved air-purifying respirator. Inspect condition and ensure fit and operation. Perform proper maintenance in accordance with OSHA Regulation 1910.134 and applicable state and local regulations. (HP-I)
e. Select and use a NIOSH-approved supplied air (Fresh Air Make-up) respirator system. Perform proper maintenance in accordance with OSHA Regulation 1910.134 and applicable state and local regulations. (HP-I)
f. Select and use the proper personal safety equipment for surface preparation, spray gun, and related equipment operation, paint mixing, matching and application, paint defects, and detailing (gloves, suits, hoods, eye and ear protection, etc.). (HP-I)

2. Surface Preparation

2.1 Plan for Preparation: Create and publish a **plan for refinishing** using a total product system. Perform **inspections** to determine the condition of the vehicle. Cite evidence to justify elements of the plan. Consult with others and revise the plan, as needed.

a. Inspect, remove, store, and replace exterior trim and components necessary for proper surface preparation. (HP-I)
b. Soap and water wash the entire vehicle; use appropriate cleaners to remove contaminants. (HP-I)
c. Inspect and identify the type of finish, surface condition, and film thickness; develop and document a plan for refinishing using a total product system. (HP-G)

2.2 Prepare Surface: Diagram the steps necessary to prepare the surfaces of a vehicle for painting. Create a **list of tools, equipment, and materials** needed for each step of preparation. Create a visual display with supporting text outlining the responsibilities and procedures of the repair technician, noting the appropriate timing of each task. Perform proper **procedures to prepare the surface of a vehicle**.

a. Strip paint to bare substrate (paint removal). (HP-I)
b. Dry or wet sand areas to be refinished. (HP-I)
c. Featheredge areas to be refinished. (HP-I)
d. Apply suitable metal treatment or primer in accordance with total product systems. (HP-I)
e. Mask and protect other areas that will not be refinished. (HP-I)
f. Mix primer, primer-surfacer, or primer-sealer. (HP-I)
g. Identify a complimentary color or shade of undercoat to improve coverage. (HP-G)
h. Apply primer onto the surface of the repaired area. (HP-I)
    i. Apply two-component finishing filler to minor surface imperfections. (HP-I)
j. Block sand area to which primer-surfacer has been applied. (HP-I)
k. Dry sand area to which finishing filler has been applied. (HP-I)
l. Remove dust from the area to be refinished, including cracks or moldings of adjacent areas. (HP-I)
m. Clean area to be refinished using a final cleaning solution. (HP-I)
n. Remove, with a tack rag, any dust or lint particles from the area to be refinished. (HP-I)
o. Apply suitable sealer to the area being refinished. (HP-I)
p. Scuff sand to remove nibs or imperfections from a sealer. (HP-I)
q. Apply stone chip-resistant coating. (HP-G)
r. Restore caulking and seam sealers to repaired areas. (HP-G)
s. Prepare adjacent panels for blending. (HP-I)
t. Identify the types of rigid, semi-rigid, or flexible plastic parts to be refinished; determine the materials needed, preparation, and refinishing procedures. (HP-I)
u. Identify metal parts to be refinished; determine the materials needed, preparation, and refinishing procedures. (HP-I)

3. Spray Gun and Related Equipment Operation

3.1 Spray Gun: Demonstrate the proper procedures involved in operating a **spray gun and related equipment.** Maintain spray guns and related equipment.

a. Inspect, clean, and determine the condition of spray guns and related equipment (air hoses, regulators, airlines, air source, and spray environment). (HP-I)
b. Select spray gun setup (fluid needle, nozzle, and cap) for the product being applied. (HP-I)
c. Test and adjust the spray gun using fluid, air, and pattern control valves. (HP-I)
d. Demonstrate an understanding of the operation of pressure spray equipment. (HP-G)

4. Paint Mixing, Matching, and Applying

4.1 Painting: Demonstrate **paint mixing** procedures. Differentiate the effects of paint ratios on the color and composition of paint to hypothesize possible outcomes of each ratio. Calculate proper formulations of paint based on label directions using formulas. Demonstrate in a live setting or in a presentation the ability to follow painting instructions precisely as they pertain to **selection, mixing, handling, and application**. Demonstrate procedures to apply **paint and refinish plastic parts** using the appropriate tools, equipment, and materials.
a. Identify color code by manufacturer's vehicle information label. (HP-I)
b. Shake, stir, reduce, catalyze/activate, and strain refinish materials. (HP-I)
c. Apply finish using appropriate spray techniques (gun arc, angle, distance, travel speed, and spray pattern overlap) for the finish being applied. (HP-I)
d. Apply the selected product on the test or let-down panel, and check for color match. (HP-I)
e. Apply single stage topcoat. (HP-G)
f. Apply basecoat/clearcoat for panel blending and panel refinishing. (HP-I)
g. Apply basecoat/clearcoat for overall refinishing. (HP-G)
h. Remove nibs or imperfections from the base coat. (HP-I)
i. Refinish rigid or semi-rigid plastic parts. (HP-G)
j. Refinish flexible plastic parts. (HP-I)
k. Apply multi-stage coats for panel blending and overall refinishing. (HP-G)
l. Identify and mix paint using a formula. (HP-I)
m. Identify poor hiding colors; determine necessary action. (HP-G)
n. Tint color using the formula to achieve a blended match. (HP-I)
o. Identify alternative color formulas to achieve a blended match. (HP-I)
p. Identify the materials, equipment, and preparation differences between solvent and waterborne technologies. (HP-G)

5. Paint Defects - Causes and Cures

5.1 Paint Defects: Identify a wide array of **paint defects**, including detailed descriptions, causes, and solutions. Compare and contrast the **characteristics and solutions** of paint defects. Demonstrate **troubleshooting strategies** appropriate for identifying and evaluating paint defects in given scenarios. Document findings in a technical report, citing evidence to recommend and justify the necessary correction procedures and methods to prevent future occurrences. Perform **proper procedures to correct paint defects**.
a. Identify blistering (raising of the paint surface, air entrapment); determine the cause(s) and correct the condition. (HP-G)

b. Identify a dry spray appearance in the paint surface; determine the cause(s) and correct the condition. (HP-I)
c. Identify the presence of fisheyes (crater-like openings) in the finish; determine the cause(s) and correct the condition. (HP-I)
d. Identify lifting; determine the cause(s) and correct the condition. (HP-G)
e. Identify clouding (mottling and streaking in metallic finishes); determine the cause(s) and correct the condition. (HP-I)
f. Identify orange peel; determine the cause(s) and correct the condition. (HP-I)
g. Identify overspray; determine the cause(s) and correct the condition. (HP-I)
h. Identify solvent popping in freshly painted surface; determine the cause(s) and correct the condition. (HP-G)
i. Identify sags and runs in the paint surface; determine the cause(s) and correct the condition. (HP-I)
j. Identify sanding marks or sand scratch swelling; determine the cause(s) and correct the condition. (HP-I)
k. Identify contour mapping/edge mapping while the finish is drying; determine the cause(s) and correct the condition. (HP-G)
l. Identify color difference (off-shade); determine the cause(s) and correct the condition. (HP-G)
m. Identify tape tracking; determine the cause(s) and correct the condition. (HP-G)
n. Identify low gloss condition; determine the cause(s) and correct the condition. (HP-G)
o. Identify poor adhesion; determine the cause(s) and correct the condition. (HP-G)
p. Identify paint cracking (shrinking, splitting, crows feet or line-checking, micro-checking, etc.); determine the cause(s) and correct the condition. (HP-G)
q. Identify corrosion; determine the cause(s) and correct the condition. (HP-G)
r. Identify dirt or dust in the paint surface; determine the cause(s) and correct the condition. (HP-I)
s. Identify water spotting; determine the cause(s) and correct the condition. (HP-G)
t. Identify finish damage caused by bird droppings, tree sap, and other natural causes; correct the condition. (HP-G)
u. Identify finish damage caused by airborne contaminants (acids, soot, rail dust, and other industrial-related causes); correct the condition. (HP-G)
v. Identify die-back conditions (dulling of the paint film showing haziness); determine the cause(s) and correct the condition. (HP-G)
w. Identify chalking (oxidation); determine the cause(s) and correct the condition. (HP-G)
x. Identify bleed-through (staining); determine the cause(s) and correct the condition. (HP-G)
y. Identify pin-holing; determine the cause(s) and correct the condition. (HP-G)
z. Identify buffing-related imperfections (swirl marks, wheel burns); correct the condition. (HP-I)
aa. Identify pigment flotation (color change through film build); determine the cause(s) and correct the condition. (HP-G)

6. Final Detail

6.1 Final Detail: Explain and demonstrate the proper procedures to complete the **final detailing for painting and refinishing** projects. Create a checklist and guide perform procedures, noting common mistakes to avoid.

a. Apply decals, transfers, tapes, woodgrains, pinstripes (painted and taped), etc. (HP-G)
b. Sand, buff, and polish fresh or existing finish to remove defects as required. (HP-I)
c. Clean interior, exterior, and glass. (HP-I)
d. Clean body openings (door jambs and edges, etc.). (HP-I)
e. Remove overspray. (HP-I)
f. Perform vehicle clean-up; complete quality control using a checklist. (HP-I)

7. Management

7.1 Quality Control: Manage **Quality Control** aspects of collision repair work.

7.2 Time Management: Discern cycle times and **determine how much time to spend on each task**.

Standards Alignment Notes

*References to other standards include:

- ASE Education Foundation standards for Collision Repair and Refinish.
- P21: Partnership for 21st Century Skills
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

Collision Repair: Damage Analysis, Estimating, and Customer Service

Primary Career Cluster:	Transportation
Course Contact:	CTE.Standards@tn.gov
Course Code:	C20H19
Prerequisite(s):	*Collision Repair: Non-Sructural* (C20H13) and/or *Collision Repair: Painting & Refinishing* (C20H14)
Credit:	1
Grade Level:	12
Elective Focus-Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Transportation courses.
Program of study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Program of Study and Sequence:	This course is the fourth and final course in the *Automotive Collision Repair* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers who hold an active WBL certificate may offer placement for credit when the requirements of the state board's WBL Framework and the Department's WBL Policy Guide are met. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	507, 771
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-transportation-distribution-logistics.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career & technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstrations. These include Career Pathways Showcase, Job Interview, Collision Damage Appraisal, Collision Repair Technology, and Automotive Refinishing Technology.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standard 2.1** | Include a safety briefing in a visit to an industry partner/job site.
- **Standards 3.1-3.2 |** Visit a local company and participate in the damage analysis done by a technician in the shop.
- **Standards 4.1 and 5.1** | Have the students complete a project that is supervised or evaluated by a manager at a local company.
- **Standards 7.1-7.3** | Participate in an internship.

Course Description

Collision Repair: Damage Analysis, Estimating, and Customer Service is the capstone course in the *Automotive Collision Repair* program of study. It is intended to prepare students for careers in the automotive repair industry. Upon completion of this course, a proficient student will be able to assess collision damage, estimate repair costs, and work with vehicle owners in a professional setting. Utilizing problem-solving strategies and resources developed in this course, including original equipment manufacturer (OEM) manuals, electronic data, and photo analysis of damaged vehicles, students will be prepared to generate work orders in a variety of collision damage

situations. Students completing the *Automotive Collision Repair* program of study will be eligible to take the examination for Automotive Student Excellence (ASE) Student Certification in Collision. Some tasks are assigned a "High Priority (HP)" designation. Accredited programs must include at least 95% of the HP-I (Individual) tasks and 90% of the HP-G (Group) tasks in the curriculum.

Course Requirements

This capstone course aligns with the requirements of the Work-Based Learning Framework (established in Tennessee State Board High School Policy), with the Tennessee Department of Education's Work-Based Learning Policy Guide, and with state and federal Child Labor Law.

Course Standards

1. Personalized Learning Plan

1.1 Personalized Learning Plan: A student will have a Personalized Learning Plan that identifies their **long-term goals**, demonstrates how the **Work-Based Learning (WBL) experience aligns with their elective focus** and/or high school plan of study, addresses how the student plans to **meet and demonstrate the course standards**, and addresses **employability skill attainment** in the following areas:

a. application of academic and technical knowledge and skills, embedded in course standards,
b. career knowledge and navigation skills,
c. 21st-century learning and innovation skills, and
d. personal and social skills.

2. Safety

2.1 Safety: Comply with **personal and environmental safety practices** associated with clothing and the use of gloves; respiratory protection; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

a. Use and inspect **personal protective equipment** every time equipment is used.
b. Inspect, maintain, and employ **safe operating procedures** with tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment.
c. Assume responsibilities under **HazCom (Hazard Communication) regulations.**
d. Adhere to responsibilities, regulations, and Occupational Safety & Health Administration (OSHA) policies regarding reporting accidents, observed hazards, and emergency response procedures.
e. Maintain a record of written safety and equipment examinations that the student has passed.

f. Utilize **SDSs (safety data sheets)** and identify the health hazards associated with hazardous material.

3. Damage Analysis

3.1 Analyze Vehicle: Gather information from a variety of print and digital sources (such as OEM manuals and online instructional materials) as well as firsthand experiences observing a qualified technician **prepare a vehicle for damage analysis**. Choose the **steps in the entire process of analyzing damage and estimating costs**. Describe how key steps are accomplished, that is, what the technician should do and observe at each step. Steps include but are not limited to the following. Note, items marked HP-I should be demonstrated by the student.

a. Position the vehicle for inspection. (HP-G)
b. Prepare the vehicle for inspection by providing access to damaged areas. (HP-G)
c. **Analyze damage** to determine appropriate methods for overall repairs. (HP-I)
d. Determine the direction, point(s) of impact, and extent of direct, indirect, and inertia damage. (HP-G)
e. **Gather details** of the incident/accident necessary to determine the full extent of vehicle damage. (HP-G)
f. Identify and record pre-existing damage. (HP-I)
g. Identify and record prior repairs. (HP-G)

3.2 Conduct Inspection: Accurately complete a **summary of damages on a claim form**, citing specific evidence to support the need for components, parts, and labor necessary to repair the vehicle. Formulate a **list of needed parts** necessary to repair the vehicle to OEM standards. Identify suspension, electrical, and mechanical elements as well as interior damage.

a. Perform visual inspection of structural components and members. (HP-G)
b. Identify structural damage using measuring tools and equipment. (HP-I)
c. Perform visual inspection of non-structural components and members. (HP-I)
d. Determine parts, components, material type(s), and procedures necessary for a proper repair. (HP-I)
e. Identify the type and condition of finish; determine if refinishing is required. (HP-I)
f. Identify suspension, electrical, and mechanical component physical damage. (HP-G)
g. Identify the safety system's physical damage. (HP-G)
h. Identify interior component damage. (HP-I)
i. Identify damage to add-on accessories and modifications. (HP-G)
j. Identify single (one-time) use components. (HP-G)

4. Damage Estimating

4.1 Gather Information: **Compile evidence** from the vehicle and owner/operator, including pictures and written summaries, to ascertain damage, determine make and model, and identify VIN information necessary to determine appropriate OEM parts.

a. Determine and record **customer/vehicle owner information**. (HP-I)

b. Identify and record **vehicle identification number (VIN) information**, including nation of origin, make, model, restraint system, body type, production date, engine type, and assembly plant. (HP-I)
c. Identify and record vehicle options, including trim level, paint code, transmission, accessories, and modifications. (HP-I)
d. Identify safety systems; determine replacement items. (HP-G)
e. Apply appropriate estimating and parts nomenclature (terminology). (HP-I)
f. Determine and apply appropriate estimating sequence. (HP-I)
g. Utilize estimating guide procedure pages. (HP-I)

4.2 Select Repairs: Determine whether **parts** will be aftermarket, recyclable, rebuilt, or reconditioned. Develop a cost analysis of **parts and labor** value for each operation required. Assess the extent of **direct and indirect damage** and the direction of impact. Develop a **repair plan** that includes a summary of damage, recommended repairs, costs of parts and labor, and necessary finishing.

a. Apply estimating guide footnotes and headnotes as needed. (HP-I)
b. Estimate labor value for operations requiring judgment. (HP-G)
c. Select the appropriate labor value for each operation (structural, non-structural, mechanical, and refinish). (HP-I)
d. Select and price OEM parts; verify availability, compatibility, and condition. (HP-G)
e. Select and price alternative/optional OEM parts; verify availability, compatibility, and condition. (HP-G)
f. Select and price aftermarket parts; verify availability, compatibility, and condition. (HP-G)
g. Select and price recyclable/used parts; verify availability, compatibility, and condition. (HP-G)
h. Select and price remanufactured, rebuilt, and reconditioned parts; verify availability, compatibility, and condition. (HP-G)
i. Determine the price and source of necessary sublet operations. (HP-G)
j. Determine labor value, prices, charges, allowances, or fees for non-included operations and miscellaneous items. (HP-G)

4.3 Estimate: Prepare written work orders for documentation of a collision repair service. Synthesize information about the number and **cost of parts** and detail the extent of the **services involved**. Apply quantitative math skills to develop an **accurate cost analysis**; then compile the work order.

a. Recognize and apply overlap deductions, included operations, and additions. (HP-I)
b. Determine additional material and charges. (HP-G)
c. Determine refinishing material and charges. (HP-I)
d. Apply math skills to establish charges and totals. (HP-I)
e. Interpret computer-assisted and manually written estimates; verify the information is current. (HP-I)
f. Identify procedural differences between computer-assisted systems and manually written estimates. (HP-G)
g. Identify procedures to restore corrosion protection; establish labor values and material charges. (HP-G)

h. Determine the cost-effectiveness of the repair and determine the approximate vehicle retail and repair value. (HP-G)
i. Recognize the differences in estimation procedures when using different information provider systems. (HP-G)
j. Verify the accuracy of the estimate compared to the actual repair and replacement operations. (HP-G)

5. Vehicle Construction and Parts Identification

5.1 Vehicle Construction and Parts Identification: Determine the **cost of components and accessories** for various makes and models of vehicles. Write **explanatory narratives** that examine and define the various components, establish the **repairability** of those components, and integrate the information accurately into the work order.

a. Identify the type of vehicle construction (space frame, unibody, body-over-frame). (HP-G)
b. Recognize the different damage characteristics of the space frame, unibody, and body-over-frame vehicles. (HP-G)
c. Identify impact energy absorbing components. (HP-G)
d. Identify steel types; determine repairability. (HP-G)
e. Identify aluminum/magnesium components; determine repairability. (HP-G)
f. Identify plastic/composite components; determine repairability. (HP-G)
g. Identify vehicle glass components and repair/replacement procedures. (HP-G)
h. Identify add-on accessories. (HP-G)

6. Customer Relations and Sales Skills

6.1 Customer Relations: **Interact respectfully** with individuals involved in various aspects of customer service, including OEM representatives, customers/clients, insurance representatives, and suppliers. **Resolve conflicts** and differences to maintain a smooth workflow. Research negotiation skills to apply them to workplace situations.

a. Acknowledge and/or **greet customer/client**. (HP-I)
b. **Listen to customer/client**; collect information and identify customer's/client's concerns, needs, and expectations. (HP-I)
c. Establish a cooperative attitude with customers/clients. (HP-I)
d. **Identify yourself** to the customer/client; offer assistance. (HP-I)
e. **Communicate with angry customers/clients**. (HP-I)
f. Identify customer/client preferred communication method; follow up to keep customer/client informed about parts and the repair process. (HP-G)
g. Recognize basic claims handling procedures; explain to customer/client. (HP-G)
h. Project a positive attitude and professional appearance. (HP-I)
i. Provide and review warranty information. (HP-I)
j. Provide and review technical and consumer protection information. (HP-G)
k. Estimate and explain the duration of out-of-service time. (HP-G)
l. Apply negotiation skills to obtain a mutual agreement. (HP-G)
m. Interpret and explain manual or computer-assisted estimates to customers/clients. (HP-I)

7. Hands-on Experience**

Option I: Internship

7.1 Internship: Participate in a **work-based learning internship** at a licensed collision repair business to develop, practice, and demonstrate skills outlined in the standards above. Internships should follow current Tennessee work-based learning guidelines and/or AYES internship guidelines as appropriate.

7.2 Journal: Create and continually update a personal **journal to document internship activities**. Draw connections between the experience and course content, thoughtfully reflecting on the following:

a. acquired leadership skills,
b. problem-solving techniques and decision-making skills,
c. team member participation in a learning environment,
d. personal career development, and
e. opportunities for industry certifications.

7.3 Assess Internship: Analyze and assess the success and failures of activities during the internship. **Summarize the internship experience** and next steps for personal and professional growth.

Option II: Portfolio

7.4 Portfolio: **Create a portfolio**, or similar collection of work, offering evidence to illustrate mastery of skills and knowledge as outlined in the standards above. The portfolio should reflect a thoughtful assessment and evaluation of the student's progression of work involving the estimation of damage to a vehicle and adherence to Safety Data Sheets (SDS). The following documents will reside in the student's electronic career portfolio:

a. personal code of professional ethics;
b. career and professional growth plan;
c. list of responsibilities undertaken throughout the course;
d. examples of visual materials developed and used during the course, such as graphics, presentation slides, videos, demonstrations;
e. description of the technology used, with examples if appropriate;
f. periodic journal entries reflecting on tasks and activities;
g. feedback from the instructor based on observations;

** Although hands-on experiences in work-based learning (WBL) are the most ideal, it is recognized that not all students will be able to be placed in a working collision establishment. While the WBL experience is encouraged, the portfolio option can be used in place of, or to supplement, an internship experience.

Standards Alignment Notes

*References to other standards include:

- ASE Education Foundation standards for Collision Repair and Refinish.
- P21: Partnership for 21st Century Skills
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

Introduction to Aerospace

Primary Career Cluster:	Transportation
Course Contact:	CTE.Standards@tn.gov
Course Code:	C20H15
Prerequisite:	None
Credit:	1
Grade Level(s):	9-10
Elective Focus-Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Transportation courses.
Program of study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the first course in the *Aviation Flight* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	512, 579, 594, 773, 774, 782
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-transportation-distribution-logistics.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

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Students engage in industry-relevant content through general education integration and experiences such as Career and Technical Student Organizations (CTSO) and Work-based Learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course; note this is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstrations. These include Career Pathways Showcase, Job Interview, Commercial sUAS Drone, and Aviation Maintenance Technology.

Using Work-Based Learning (WB) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1** | Include a safety briefing during a visit to an airport.
- **Standards 2.1 |** Have a pilot and maintenance technician visit the class to talk about careers.
- **Standard 3.1** | Have an experienced pilot or maintenance technician visit the class to talk about some of their aviation experiences.
- **Standards 4.1–4.3** | Visit an airfield and ask a pilot to give an overview of their aircraft.
- **Standards 5.1-5.4** | Ask a pilot to discuss flight environments and situations they have experienced.

Course Description

Introduction to Aerospace is a comprehensive foundational course for students interested in pursuing careers in aviation. This course covers the basic principles governing flight and the regulation of flight that every aviation professional must know regardless of his or her occupation—as a pilot or an engineer, a salesperson or a specialist, a mechanic or a statistician. In addition to acquiring foundational knowledge of safety procedures and industry regulations, students will also gain an essential understanding of aircraft structures, the flight environment, basic procedures, and

navigation. Upon completion of this course, proficient students will be prepared for further study in advanced *Aviation Flight* and/or *Aviation Maintenance* courses.

Course Standards

1. Aviation Safety

1.1 Safety: The number one priority of aviation personnel is to maintain the **safety of flight**. Identify the **basic safety issues** that a pilot must be aware of before, during, and after each flight, including but not limited to the pilot's mental and physical condition, collision avoidance, weather conditions, maintaining minimum safe altitudes, visual scanning, right of way rules, flight over hazardous terrain, positive exchange of flight controls, operating within the aircraft's approved weight and balance, and airspeed limitations.

2. Career Opportunities in Aviation

2.1 Career Options: Summarize the wide range of **career pathways** available in aviation today. Careers may include but are not limited to pilots, airframe and powerplant mechanics (A&P), aeromechanical engineers, airport operators, airline statisticians, Air Traffic Controllers (ATC), Flight Service Specialists (FSS), aircraft manufacturing, and aircraft sales. Explain the essential **knowledge and skills** required for careers in aviation. Describe important **aptitudes for success** in these careers, such as mechanical, verbal, scientific, manipulative, numerical, administrative, social, and artistic.

2.2 Organizations: Investigate **regulatory agencies, governing bodies, and professional organizations** related to the aviation industry, such as the Federal Aviation Administration (FAA), the National Transportation Safety Board (NTSB), and the National Aeronautics and Space Administration (NASA). Explain their functions, jurisdictions, and importance within the industry.

2.3 Career and Technical Student Organization Introduction: **Introduce the program's aligned CTSO**, SkillsUSA, through an interactive activity, such as a classroom competition.

3. History of Aviation

3.1 History: Understand the timeline of **historical milestones in the development of flight**. Describe the major obstacles that were overcome to achieve controlled, sustained, and powered heavier-than-air flight. Identify **major contributors** to the field of aviation, including scientists, inventors, pilots, and other historical figures, and determine what each person contributed. Discuss their impact on both the development of flight as well as the industry as a whole.

4. Aircraft Structures and Systems

4.1 Major Components: Identify the 5 major parts of an Airplane and understand the purpose of each major component. The major components are the **Fuselage, Empennage, Wings, Landing Gear, and Powerplant**. Landing Gear knowledge should include Conventional (Tail Wheel), Tricycle types, Fixed, and Retractable configurations. Powerplant knowledge should include Reciprocating, Turbo Prop, Turbo Jet, and electric engine terminology and theory. Propeller knowledge should include operating theory for Fixed and Constant Speed Propellers, as well as propellers made of composite material.

4.2 Systems: Identify and understand the **purpose of the Aircraft Systems and how they interact** with each other. The Aircraft Systems include the Fuel, Electrical, Ignition, Exhaust, Engine Instruments, Comm/Nav and Flight Instruments.

4.3 Flight and Stability: Identify and understand the purpose of the **Primary and Secondary Flight Control Surfaces, the Three Axis of Flight, and Basic Aircraft Stability**.

5. Flight Environment

5.1 Aircraft Airworthiness: Understand and explain **basic operation of the following phases of flight**:

a. basic aerodynamics,
b. preflight,
c. postflight,
d. weight and balance (Develop a practical understanding of weight and balance conditions and their significance in aircraft performance and safety. Calculate the weight and balance for an aircraft, considering factors such as passenger and cargo distribution, fuel load, and center of gravity limits.),
e. fuel requirements,
f. wake turbulence,
g. collision avoidance, and
h. documentation (Document the process and findings, including observations and thought processes, with other artifacts for inclusion in a program portfolio.).

5.2 Airport Operations: Understand **Air Traffic Control (ATC) procedures related to Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) operations**. Explain the circumstances and conditions of operation regarding airport operations and local area procedures.

5.3 Airspace: Understand the characteristics of the two basic types of **airspace.**

a. Controlled
b. Uncontrolled

5.4 Weather: Explain the importance of **meteorological knowledge regarding visual and instrument flight** and become familiar with key concepts and terminology for the following:
   a. basic weather theory,
   b. VFR minimums, and
   c. IFR minimums.

6. Basic Navigation

6.1 Navigation: Explain how basic **Pilotage and Dead Reckoning (DR) techniques** work, and recognize when they are appropriate. Describe how pilots use such techniques to fly from one point or location to another.

7. Judgment Training

7.1 Judgment: Summarize techniques for improving **pilot judgment and decision-making skills**. Develop an original mock scenario in which a pilot must react to an in-flight complication or malfunction. Explain a strategy for remaining calm under pressure, maintaining lines of communication, and making sound decisions.

8. Data Analysis and Artificial Intelligence

8.1 Data Analysis in Transportation: **Research the use of data** in the transportation career fields. Include data that is generated internally by businesses, and externally by local communities, state, and the nation. Explore examples of how data is used, including the following:
   a. customer/client use of products and services in aviation,
   b. demographics of end users of aviation services and facilities,
   c. community, state, and national statistics related to aviation, and
   d. data that must be reported to another activity that impacts aviation.

8.2 Ethical Artificial Intelligence (AI): **Explore the ethical implications of AI usage** through interactive discussions and case studies, learning to identify bias, ensure fairness, and protect privacy in AI systems. **Develop** critical thinking **skills to evaluate the societal impact of AI technologies**, while fostering a sense of responsibility and ethical decision-making in the use of AI tools.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills
  - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

Aviation I: Principles of Flight

Primary Career Cluster:	Transportation
Course Contact:	CTE.Standards@tn.gov
Course Code:	C20H16
Prerequisite:	*Introduction to Aerospace* (C20H15)
Credit:	1
Grade Level(s):	10-11
Elective Focus-Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Transportation courses.
Program of study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Program of Study and Sequence:	This is the second course in the *Aviation Flight* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	594, 774
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-transportation-distribution-logistics.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as Career and Technical Student Organizations (CTSO) and Work-based Learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstrations. These include Career Pathways Showcase, Job Interview, Commercial sUAS Drone, and Aviation Maintenance Technology.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1-1.2** | Include a safety briefing during a visit to an airport.
- **Standard 3.1-3.6 |** Have a pilot and maintenance technician visit the class to talk about aircraft structures and systems.
- **Standards 4.1-4.2** | Ask a pilot to discuss the flight environment with the class.
- **Standards 8.1-8.10** | On an airplane, ask a pilot or crew member to talk with the students about navigation.

Course Description

Aviation I: Principles of Flight builds on the fundamental knowledge and skills learned in *Introduction to Aerospace* while teaching students the essential competencies needed for flight under normal conditions. Upon completion of this course, proficient students will be able to apply knowledge, skills, and procedures in a variety of simulated flight environments. Moreover, students who complete this course will have the opportunity to move on to advanced study in *Aviation II: Advanced Flight*, where they will continue to prepare for the FAA Private Pilot written exam.

Course Standards

1. Aviation Safety

1.1 Safety: Identify the **basic safety issues** a pilot must be aware of **before, during, and after each flight**, including but not limited to the pilot's mental and physical condition, collision avoidance, weather conditions, maintaining minimum safe altitudes, visual scanning, wake turbulence, right-of-way rules, flight over hazardous terrain, positive exchange of flight controls, preflight planning, fuel requirements, post-flight analysis, and operating within the Federal Aviation Regulations (FARs). Discuss takeaways to incorporate into future decision making and thought processes that would help in preparation to be a safer pilot or mechanic.

1.2 Accident: Evaluate at least one aviation **National Transportation Safety Board (NTSB) accident report** and share with the class the NTSB findings, probable causes of the accident, and any NTSB recommendations based on their findings. Devise strategies for being a safer pilot or mechanic based on what they learned.

2. Aerodynamics

2.1 Aerodynamics: Explain the **interrelationships among aerodynamics forces** that affect an aircraft on the ground and in flight. Aerodynamic forces include, but are not limited to ground effect, torque and P-factor, load factor, and aircraft stability. In addition, be able to explain the effects of frost, the significance of angle of attack as it relates to stalls and spins, and how load factors are affected by airplane turns.

3. Aircraft Structures/Systems

3.1 Components: Describe the characteristics and functions of an **airplane's aileron, elevator, and rudder**, including the trim system if appropriate, citing technical manuals and industry guidelines. Detail the varying effects of changes in airspeed, density altitude, frost, snow, or ice on each of these functions. Explain the operation of aircraft slats, spoilers, speed brakes, and thrust reversers.

3.2 Engine: Compare and contrast the characteristics and operating principles of both a **normally aspirated and turbocharged aircraft reciprocating engine**, and then relate the advantages and disadvantages of each. Explain **how a turbine engine operates**, including the different sections within the engine, and relate the advantages and disadvantages between a turbo jet, turbo fan, and turbo prop engine.

3.3 Systems: Describe the characteristics and chief functions of the following **aircraft systems or instrumentation systems**: pitot-static system, vacuum system, flight gyros, navigation radios (such as VOR and GPS), and aircraft communications radios. In the context of a

specific aircraft, explain the advantages and disadvantages of a glass cockpit versus steam gauges.

3.4 Fuel: Describe the **fuel system in a typical training aircraft**, highlighting at minimum the following elements: fuel tanks, fuel selector valves, fuel drains, fuel pump(s), carburetor, and fuel injected systems. Distinguish between different types of aviation fuels by sight, color, and/or smell, and determine which type of fuel would be acceptable to use in a reciprocating and/or turbine aircraft engine.

3.5 Electrical System: Describe the **electrical system in a typical training aircraft**, highlighting at minimum the following elements: battery, alternator/generator, circuit breakers (CBs), and 12-volt and 24-volt systems.

3.6 Landing Gear: Describe how a **retractable landing gear system** operates in a typical training aircraft, citing aircraft handbooks and other manuals for illustration during normal operation procedures as well as emergency operation procedures. Describe or illustrate the differences between electrical pump and hydraulic pump systems.

4. Flight Environment

4.1 Airspace: Explain the **restrictions associated with each classification of airspace**: Class A, B, C, D, E, G, Airport Advisory Areas, prohibited or restricted airspace, alert areas, warning areas, and minimum obstruction clearance altitudes(MOCAs). Articulate what relevant laws and regulations govern and apply to airspaces as set forth by the Federal Aviation Regulations.

4.2 Components of Flight Environment: Describe the functions of and explain the differences between each of the following **aspects of the flight environment**: clearance delivery, ground controls, towers, approach/departure controls, terminal radar programs, air route traffic centers (ARTC), and flight service stations (FSS).

5. Communications

5.1 Communications: Explain the **communication** involved in the following scenarios:

a. **Controlled Airport – Departure**
   i. Automated Terminal Information Service (ATIS)
   ii. Clearance Delivery (assigned headings, altitudes, transponder codes, departure frequencies)
   iii. Ground Control (taxi instructions)
   iv. Tower (Visual Flight Rules (VFR) flight plan activation)
   v. Departure Control

b. **Controlled Airport – Arrival**
   i. ATIS
   ii. Approach Control

iii. Tower
iv. VFR Flight Plan Closure
v. Ground Control (taxi instructions)

c. **Non-Controlled Airport – Departure**
   i. Automated Weather Observing System (AWOS)
   ii. Common Traffic Advisory Frequency (CTAF) / Unicom (pre-taxi communication, pre-takeoff communication)
   iii. Proceeding on Course
   iv. VFR Flight Plan Activation

d. **Non-Controlled Airport – Arrival**
   i. AWOS
   ii. CTAF / Unicom (airport advisory, pre-pattern communication, pattern communication, base communication, clearing runway communication)
   iii. VFR Flight Plan Closure

6. Human Factors

6.1 Human Factors: Demonstrate understanding of the **five hazardous thoughts and associated antidotes** to each of the following:
   a. anti-authority,
   b. impulsivity,
   c. invulnerability,
   d. macho, and
   e. resignation.

Students will determine if they have one or more of these hazardous thoughts and explain what they do to realize when their decisions may be influenced by a hazardous thought. Students should also explain how they will counteract this thought to remain as safe as possible.

7. Weather

7.1 Weather: Retrieve and synthesize **weather information in a timely fashion to aid in aviation decision-making**: Aviation Routine Weather Reports (METAR)s, Pilot Weather Reports (PIREP)s, Aviation Area Forecasts, and Terminal Aerodrome Forecasts (TAF). Make appropriate go/no go weather decisions based on the information retrieved. Demonstrate different ways to obtain a weather briefing while on the ground (phone call to FSS, internet, or Aviation App), and explain what a pilot should do to get an updated weather briefing while airborne (FSS, Aviation App, ATC, or XM Weather). Pilots should always be aware of limitations associated with receiving in-air weather information.

8. Navigation

8.1 Best Route: Determine the different **factors involved in planning the best route** on each leg of a cross-country flight. For each factor, describe why it should be considered when

determining the route, citing by contrast, what could go wrong if the factor was not considered. Examples include the following:

a. shortest distance,
b. lowest terrain,
c. best emergency landing options, and
d. smoothest air.

8.2 Best Altitude: Determine the different **factors involved in calculating the best altitude** to fly on each leg of a cross-country flight. Factors may include the following:

a. VFR – Easterly heading (odd thousand + 500') or Westerly heading (even thousand + 500');
b. IFR – Easterly heading (odd thousand) or Westerly heading (even thousand) (below FL 290);
c. distance between departure airport and destination airport;
d. headwind/tailwind components at different altitudes;
e. terrain features;
f. emergency landing options; and
g. smoothest air.

8.3 Headwind and Tailwind: Given a specific flight route, **determine the headwind/tailwind** component on each leg of a cross-country flight, including the following:

a. determine forecast winds aloft for each leg,
b. determine the best altitude for each leg, and
c. determine the headwind/tailwind component for each leg.

8.4 Groundspeed: Given a specific flight route, **determine the estimated ground speed** on each leg of a cross-country flight, including the following:

a. determine altitude,
b. determine true airspeed (TAS),
c. determine headwind/tailwind component,
d. determine crosswind component, and
e. determine estimated groundspeed (GS).

8.5 Magnetic Heading: Given a specific flight route, **determine the estimated magnetic heading** required for each leg of a cross-country flight, including the following:

a. determine True Course (TC) / Magnetic Course (MC);
b. determine crosswind component;
c. determine True Heading (TH);
d. determine the amount of variation, and show how to add variation if it is a Westerly variation and subtract variation if it is an Easterly variation; and
e. determine Magnetic Heading (MH).

8.6 Visual Flight Rules (VFR) Flight Plan: Correctly simulate how to complete, file, activate, and close or cancel a **VFR flight plan**, following proper procedures and determining the information requested in each box of the flight plan.

8.7 Communications and Navigation Systems: Describe how to use the **communication radios and navigation systems**. Identify limitations as to their useful range. Explain the process around confirming that each radio or equipment is in working condition per the manufacturer's operating manual or normal operation procedures. Students will also understand and explain the following transponder codes (1200, 7700, 7600, and 7500) and be able to list what each code communicates to ATC, as well as the function of Mode C and the "Ident" button.

8.8 Global Positioning System (GPS): Accurately express how the basic **GPS system** works in an aircraft and cite specific **principles of operation** to determine the advantages and disadvantages of GPS navigation over the VOR system.

8.9 Aeronautical Charts: Clearly explain how to use **aeronautical charts** during a cross-country flight to determine an aircraft's position by use of Pilotage and Dead Reckoning (DR). Demonstrate proficiency in the use of lines of latitude and longitude to determine checkpoints or landmarks on an aeronautical chart and be able to input that information into a GPS for navigation purposes. Analyze the information retrieved to determine the necessary radio frequencies listed, the different types of airspace, and the altitudes of that airspace by using a sectional and/or world aeronautical chart.

8.10 Very High-Frequency Omni-Directional Range (VOR): Understand and be able to clearly explain how to use a **VOR for navigation purposes**, determine an aircraft's position, and determine the Radial From a VOR facility and Bearing To a VOR facility. Additionally, determine when an aircraft crosses over a VOR station.

9. Aircraft Performance and Weight and Balance

9.1 Density Altitude Impact: Describe the **effects of density altitude on aircraft performance**. Given a particular set of conditions, determine and accurately perform density altitude computations.

9.2 Headwind, Tailwind, and Crosswind During Takeoff and Landing: Determine the **headwind/tailwind and crosswind components for takeoff and landing**. Explain how each component was determined; based on the analysis, evaluate if the crosswind component is within the manufacturer's approved or demonstrated crosswind component.

9.3 Takeoff Distances: Determine the required **takeoff run and takeoff distance** to clear a fifty-foot obstacle, required landing roll, and landing distance to clear fifty-foot obstacle distances based on projected aircraft weight, headwind/tailwind component, density altitude, and surface conditions.

9.4 Cruise Setting: Determine **aircraft cruise power settings**. Explain how different cruise power settings were determined, citing the advantages and disadvantages of each.

9.5 Weight and Balance: Confirm that the projected weight is within the manufacturer's approved maximum takeoff and landing weights and that the center of gravity is within the manufacturer's approved takeoff Center of Gravity (CG) envelope. Explain **weight and balance definitions** and relate how to reduce the payload as needed to bring the aircraft within the manufacturer's approved maximum takeoff weight. Determine how to move passengers and/or cargo to bring the center of gravity within the manufacturer's approved takeoff CG envelope.

10. Team Project

10.1 Team Project with Data Analysis: As a team, **identify a problem** related to the program of study as a whole. **Research and utilize the Engineering Design Process to design a solution.** Document the following steps in an engineering design notebook for inclusion in the program portfolio. When possible, connect the problem to an existing SkillsUSA event.

a. **Problem Identification**: Brainstorm specific problems and challenges with the program of study. Conduct basic research to understand the scope and implications of the identified problem. Identfy one problem as a focus area.
b. **Research and Analysis**: Conduct in-depth research on chosen topics related to the problem. Locate and analyze a dataset related to the problem.
c. **Review the Stages of the Engineering Design Process**: Define the problem, research, brainstorm solutions, develop prototypes, test and evlauate, and iterate. Consider constraints such as cost, efficiency, and environmental impact during the design process.
d. **Project Implementation**: Assign specific roles within the design teams (e.g., project manager, researcher, designer, tester). Design a solution tailored to address the identified problem or scenario. Document progress through design journals, sketches, diagrams, and digital presentations. (Note: Prototype is optional in the Year 2 course.)
e. **Presentation and Reflection**: Showcase the problem and solution to the class. Share the data that was analyzed and how it affected the solution. Discuss the design process and challenges. As a class, critically evaluate the effectiveness and feasibility of the solutions and propose potential improvements.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

Aviation II: Advanced Flight

Primary Career Cluster:	Transportation
Course Contact:	CTE.Standards@tn.gov
Course Code:	C20H18
Prerequisite:	*Aviation I: Principles of Flight* (C20H16)
Credit:	1
Grade Level(s):	11-12
Elective Focus-Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Transportation courses.
Program of study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Program of Study and Sequence:	This is the third course in the *Aviation Flight* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	594, 774
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-transportation-distribution-logistics.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

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Students engage in industry-relevant content through general education integration and experiences such as Career & Technical Student Organizations (CTSO) and Work-based Learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course; note this is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstrations. These include Career Pathways Showcase, Job Interview, Commercial sUAS Drone, and Aviation Maintenance Technology.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1-1.2** | Have a pilot discuss aerodynamics with the students.
- **Standard 2.1-2.3 |** Have a pilot and maintenance technician visit the class to talk about airplanes.
- **Standards 3.1-3.4** | Have a pilot discuss airports and airspace with the students.
- **Standards 5.1-11.2** | Ask a pilot to discuss situations they have experienced. If possible, have the students fly in an airplane to enhance the experience.

Course Description

Aviation II: Advanced Flight is the capstone course in the *Aviation Flight* program of study intended to prepare students for careers in aviation. While continuing to build upon the knowledge, skills, and competencies acquired in *Introduction to Aerospace* and *Aviation I*, students in *Aviation II* will receive rigorous instruction in preparation to take the Federal Aviation Administration (FAA) Private Pilot written exam. This course goes beyond the mastery of procedures under normal conditions learned in *Aviation I: Principles of Flight* and introduces students to the troubleshooting and diagnostic techniques used by pilots and other aircraft personnel to assess and correct for malfunctions, make adjustments in hazardous weather conditions, and perform other crucial emergency procedures.

Continued emphasis is placed on maintaining the safety of flight and developing sound judgment ("judgment training") throughout these conditions.

In addition, students will develop a keen understanding of advanced aerodynamics and the physics of flight to aid in decision-making and technical adjustments while working under simulated abnormal procedures. Finally, upon graduation, proficient students will be better prepared to begin flight training in pursuit of a private pilot's license should they choose.

Flight simulators are required to fully master many of the standards in this course. Instructors may use a range of equipment to meet this requirement, from simple computer software such as Microsoft Flight SimX to advanced freestanding simulators such as the Redbird FMX. This course also draws on preparation materials for the FAA Private Pilot Ground Test.

Course Standards

1. Airplanes and Aerodynamics

1.1 Aerodynamics: Demonstrate a thorough understanding of the **aerodynamic forces** that are enacted on an airplane at various phases of flight. Explain why the airplane reacts to aerodynamic forces during stalls, wingtip vortices, and wake turbulence.

1.2 Stalls: Explain the situation and characteristics leading up to a **stall, the various types of stalls, and stall recovery techniques**. Demonstrate using a simulator, as available. Explain what to do during a spin and how to recover safely from a spin.

2. Airplane Instruments, Engines and Systems

2.1 Instruments and Systems: Explain the **airplane instruments and systems** including pitot static, vacuum, electric, fuel, and hydraulic systems. Demonstrate using a simulator, as available.

2.2 Engines: Explain **engine operation, leaning techniques, and troubleshooting** for failed instruments/engine(s).

2.3 Engine Failure: Explain the proper use of checklist items for **engine failure** in flight at altitude as well as at various phases of flight. Demonstrate using a simulator, as available.

3. Airports, Air Traffic Control and Airspace

3.1 Airports: Demonstrate full understanding of **towered and non-towered airports**, lighting, markings, signage, taxiways, runways, airport diagrams, characteristics, and frequencies.

3.2 Airspace: Explain and identify **all classes of airspace** on an aeronautical chart, including cloud clearance and visibility requirements for flight in VFR conditions.

3.3 Special Use Airspace: Explain and identify the various types of **special use airspace** on an aeronautical chart.

3.4 Air Traffic Control: Demonstrate how to correctly exchange **dialogue with Ground, Tower, and Enroute Controllers** using proper aviation phraseology.

4. Federal Aviation Regulations

4.1 Federal Aviation Regulations: Explain the rules in **FAR Part 61 (Certification for Pilots) and FAR Part 91 (General Operating and Flight Rules)**. Students should be familiar with the FARs with respect to their role as student pilots and future holders of a Private Pilot Certificate. Identify additional certificates and ratings beyond the Private Pilot Certificate.

5. Airplane Performance and Weight and Balance

5.1 Performance, Weight, and Balance: Calculate various **performance, weight, and balance** scenarios using the Pilot's Operating Handbook for a given aircraft along with an E6B, rotary, or electronic E6B (Sporty's). *Note that a phone with an E6B app will not be allowed in the testing room for the FAA Private Pilot Knowledge Exam. Specific real-world scenarios and accidents will be discussed.*

6. Private Pilot Maneuvers

6.1 Maneuvers: Discuss the **Airman Certification Standards** and how each maneuver is to be performed within acceptable limits. *This topic is largely dependent on access to a Flight Training Device (simulator).* Using a simulator, **fly demonstrating climbs, straight and level, and turns**. Depending on instructor knowledge, timing, and simulator availability, students may practice the maneuvers required on the Private Pilot Practical Test.

7. Aeromedical Factors and Aeronautical Decision-Making

7.1 Aeronautical Decision-Making: Recognize the symptoms and explain how to react properly to **aeromedical factors** affecting a pilot, including, but not limited to effects of changes in air pressure, ear and sinus blockage, toothaches, stress, fatigue, noise, alcohol/drugs, hypoxia, hyperventilation, spatial disorientation, vision issues, and carbon monoxide poisoning. Perform a preflight self-inspection and determine airworthiness. Discuss **aeronautical decision-making** in real-world scenarios using accident data.

8. Weather

8.1 Weather Impact: Explain all necessary Private Pilot Knowledge of **weather topics,** including reports, forecasts, charts, and graphs. Discuss the explicit **dangers, causes, and effects** of thunderstorms; discuss airframe and carburetor icing; mountain waves, wind shear, and temperature/dew point. Describe the factors involved in the formation and dissipation of fog, temperature inversions, and clouds. Apply mathematics concepts to determine the stability or instability of an air mass. Explain the "go"/no go" decision that must be made when examining weather as well as personal minimums vs legal minimums.

8.2 Weather Sources: Explain the various ways to utilize **aviation weather services** during preflight and inflight. Demonstrate a call to an actual weather briefer. (800-WX-BRIEF). Demonstrate different ways to obtain a weather briefing while on the ground (phone call to FSS, internet, and Aviation Apps). Explain what a pilot should do to get an updated weather briefing while airborne (FSS, ATC, and Aviation Apps). Analyze **weather sources**, synthesize the information found, and demonstrate the ability to retrieve the correct information in a timely fashion to aid in aviation decision-making. Use the following sources: METARs, TAFs, Weather Depiction Charts, Radar Summary Charts and Radar Weather Reports, Wind and Temperature Aloft Forecasts (FB), Significant Weather Prognostic Charts, AIRMETs and SIGMETs.

9. Navigation, Charts and Publications

9.1 Navigation: Demonstrate correct knowledge of various forms of **navigation**. Determine the correct latitude/longitude on/from a chart, convert local time to and from Zulu time, and be familiar with the various **charts and publications** available from the FAA.

9.2 Pilotage: Explain **pilotage, dead reckoning, VOR, and GPS usage and operation**. Demonstrate using a simulator, as available.

10. Cross-Country Flight Planning

10.1 Cross-Country Planning: Create a successful and complete NavLog for a **cross-country flight**. Demonstrate using a simulator, as available. Demonstrate how to handle a diversion to a different airport.

10.2 Flight Planning Tools: Describe and identify the differences between **Clearance Delivery, Ground Controls, Towers, Approach/Departure Controls, Terminal Radar Programs, Air Route Traffic Centers (ARTC), and Flight Service Stations (FSS).**

11. Emergencies

11.1 Inflight Emergency: Explain how to handle an **emergency while in flight**. Demonstrate successful use of memory items and appropriate emergency checklists for various phases of flight. Demonstrate using a simulator, as available.

11.2 Pilot Judgment and Decision-Making: Demonstrate an understanding of proper techniques for improving **pilot judgment and decision-making** skills in every aspect of the pre-flight, in-flight, and post-flight stages.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

Unmanned Aircraft Systems Pilot

Primary Career Cluster:	Transportation
Course Contact:	CTE.Standards@tn.gov
Course Code:	C20H29
Prerequisite:	None
Credit:	1
Grade Level(s):	11 or 12
Elective Focus-Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Transportation courses.
Program of study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Program of Study and Sequence:	This is the fourth and final course in the *Aviation Flight* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	512, 579, 594, 773, 774, 782
Required Teacher Certifications:	Please refer to Occupational Educator Licensure Guidance for a full list.
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-transportation-distribution-logistics.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st-century skills necessary to be successful in careers and life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career & technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course; note this is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstrations. These include Career Pathways Showcase, Job Interview, Commercial sUAS Drone, and Aviation Maintenance Technology.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standard 1.1** | Have a commercial drone pilot discuss career opportunities.
- **Standards 2.1-7.3 |** Have an active drone pilot discuss the realities of flying drones in various conditions.
- **Standards 8.1-8.3 |** Visit an airfield and discuss drones with the operations manager.
- **Standards 9.1-10.1 |** Visit a commercial drone pilot while they are conducting a mission.

Course Description

Unmanned Aircraft Systems Pilot is a course intended to prepare students for positions as commercial drone pilots for small Unmanned Aircraft Systems (sUAS). The course teaches students the knowledge and skills needed to successfully pilot sUAS (less than 55 lbs.). Students in *Unmanned Aircraft Systems Pilot* will receive rigorous instruction in preparation to take the Federal Aviation Administration (FAA) Remote Pilot Certification (Part 107) written exam also called the aeronautical knowledge exam. The course emphasizes applicable regulations, operating requirements, weather impacts, charts, aeronautical decision-making, and safety.

Course Standards

1. Careers

1.1 Careers: Identify and describe essential knowledge and skills for jobs within the small Unmanned Aircraft Systems (sUAS) field. Analyze **current sUAS jobs, job locations, salaries, upcoming career shifts** related to sUAS technology, and how sUAS positions relate to other aviation positions.

2. Flight Operations, Performance, and Weather

2.1 Performance: Exhibit a thorough understanding of small Unmanned Aircraft Systems (sUAS) **performance topics**:

a. function of flight controllers,
b. types of control,
c. performance and efficiency related to sUAS operations,
d. propulsion and power, and
e. operating limits.

2.2 Pilot in Command: Explain the **responsibility and authority of the pilot in command** (PIC) for a small Unmanned Aircraft Systems (sUAS) mission. Demonstrate the PIC responsibilities for each step of a flight (pre-flight, normal in-flight, abnormal in-flight, emergency in-flight, and post-flight).

2.3 Weather: Evaluate weather reports from various sources, including METAR and Terminal Aerodrome Forecasts, to interpret projected weather conditions for operating small Unmanned Aircraft Systems (sUAS). Explain the various **weather conditions' impacts on sUAS operations.**

2.4 Night Operations: Explain **night operations** with a small Unmanned Aircraft System (sUAS). Plan the various steps of a night mission with a sUAS.

3. Operating Requirements and Loading

3.1 Flight Planning: Demonstrate **flight planning skills** by developing and comparing three different flight plan options for one mission. Justify which flight plan option is best to include safety, airport operations, Federal Aviation Authority regulations, weather, aircraft performance, and mission success.

3.2 Operating Requirements: Examine the **operating requirements of a small Unmanned Aircraft System** (sUAS) that includes the following:

a. identifying and differentiating levels of unmanned aerial system autonomy;
b. identifying the Ground Control Station and explaining its purpose;

c. explaining operations over human beings;
d. explaining requirements when a visual observer is used;
e. explaining how to operate from a moving aircraft or moving land or waterborne vehicle;
f. identifying aircraft safety of flight principles and describing the basic rules of safe operations;
g. evaluating the requirements for the sUAS to be in a condition for safe operation; and
h. demonstrating an understanding of hazardous operations.

3.3 Loading: Evaluate the **impact of loading on the performance of small Unmanned Aircraft Systems** (sUAS). Explain the following:
a. payload as it applies to sUAS,
b. historical payload uses,
c. factors to consider when designing payloads,
d. purpose and use of various camera systems, and
e. prohibitions for carrying hazardous material.

3.4 Compare Aircraft: Assess the impact of **different small Unmanned Aircraft Systems (sUAS) platforms** on varying missions. For example, given specific missions, explain which sUAS platform, including software, would be most successful for each mission.

3.5 Remote Identification: Explain **remote identification** for small Unmanned Aircraft Systems to include FAA Recognized Identification Areas. Plan a mission using remote identification.

4. Aeronautical Decision-Making

4.1 Principles of Flight: Explain the **fundamentals and principles of flight** as they relate to small Unmanned Aircraft Systems. Include aeronautical principles, aerodynamics, lift, drag, thrust, weight, acceleration, objects in motion through the air, and the forces that produce change to such motions.

4.2 Charts: Interpret **sectional charts, aeronautical charts, and chart supplements**. For example, calculate the correct answers to given specific chart reading questions, which include latitude, longitude, obstacles, navigation routes, the meaning of symbols, key terms, and the technical context of other specific words related to small Unmanned Aircraft Systems. Examples include ICAO Location Indicators, Warning Areas, Outer Boundaries, and Temporary Flight Restrictions (TFR) Sites.

5. Safety and Emergency Procedures

5.1 Safe Operations: Interpret safety rules related to operating and using small Unmanned Aircraft Systems (sUAS). While preparing and flying a mission, **demonstrate safe operations** with the sUAS aircraft, tools, and equipment. Practice the appropriate attitudes and behaviors associated with the safe handling and operation of sUAS.

5.2 Hazards: Recognize **hazards related to avoiding birds and wildlife** while operating the small Unmanned Aircraft Systems (sUAS). Explain requirements to report collisions between sUAS and animals.

5.3 Emergency Procedures: Employ appropriate **emergency procedures**. Explain reporting requirements for in-flight emergencies and appropriate action during loss of aircraft control link and fly-aways.

5.4 Flight Operations Over People: Explain **safe flight operations over people**. Plan a mission that requires safe flight operations over people.

6. Regulations, Airspace Classification, and Flight Restrictions

6.1 FAA Regulations: Demonstrate an **understanding of Federal Aviation Authority regulations,** including registration requirements, categories of vehicles, system operators, ramifications of false reporting, accident reporting, and prohibition of operating multiple small Unmanned Aircraft Systems.

6.2 Airspace Classification: Classify **airspace, including general, special, and other airspace**. Identify **where a small Unmanned Aircraft Systems can and cannot be flown**. Describe the operating requirements in certain airspaces, including restrictions due to NOTAM (Notice to Armen), prior authorization requirements, and prohibited and restricted airspace.

6.3 Restricted Space: Identify various **methods to prevent accidental flight into restricted spaces**. For example, given a specific region and using researched sources of information, create a geo-fence around unauthorized areas. Establish this "virtual barrier" to send a text message, email alert, or app notification when the Unmanned Aircraft System enters or exits the specified area.

7. Crew Resource Management and Effects of Drugs and Alcohol

7.1 Crew Resource Management: Explain **crew resource management** to include identifying the medical conditions that would interfere with the safe operations of a small Unmanned Aircraft System and factors affecting vision and fitness for flight.

7.2 Drugs and Alcohol: Analyze the **human factors** related to safe aircraft operations. Include the prohibition of the use of drugs and alcohol, the **impact of drugs and alcohol** including physiological effects of drugs and alcohol, and the consequences of refusing to submit to a drug or alcohol test or to furnish results.

7.3 Crew Operations: Simulate a full small Unmanned Aircraft Systems **crew during an operational flight,** employing aviation terminology and technical vocabulary.

8. Airport Operations and Radio Communication Procedures

8.1 Airport Operations: Identify the impacts small Unmanned Aircraft Systems (sUAS) have on airports. Explain how to **manage the impact a sUAS may have on airport operations** including the following:

a. distance from other aircraft,
b. right-of-way rules,
c. how to operate in the vicinity of airports,
d. airport procedures,
e. airport environment, and
f. operation with and without control towers.

8.2 Radio Communications: Using a radio or simulated setup, demonstrate **effective communication skills while using proper radio communication procedures,** including Zulu time and the phonetic alphabet.

8.3 Communications Equipment: Demonstrate knowledge of **aircraft communication equipment,** including the various transmitters.

9. Maintenance and Preflight Inspection Procedures

9.1 Equipment and Tools: Identify **equipment and tools related to small Unmanned Aircraft Systems**. Properly inspect and use equipment and tools related to small Unmanned Aircraft Systems.

9.2 Preflight Inspection: Troubleshoot and maintain a small Unmanned Aircraft System (sUAS) before a mission. Using the Federal Aviation Authority **preflight checklist, conduct maintenance and preflight inspection procedures** on a sUAS aircraft.

10. Flight

10.1 Flight Time: **Plan and execute three sUAS missions** using small Unmanned Aircraft Systems (sUAS) while serving as a pilot in command. Each mission will include the following:

a. creating an autonomous flight plan that is safe and fully complies with Federal Aviation Authority regulations within the National Airspace;
b. completing the planned objective;
c. demonstrating mission planning, preparation, execution, and the post-flight debrief;
d. maintaining safe operating procedures;
e. demonstrating situational awareness;
f. performing risk mitigation; and
g. practicing standards of professionalism.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.