Maryland
STATE DEPARTMENT OF EDUCATION

Program of Study Guide: Automotive Collision Repair and Refinishing - DRAFT

Comprehensive guidelines and course standards for the Automotive Collision Repair and Refinishing pathway

Office of College and Career Pathways

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MARYLAND STATE DEPARTMENT OF EDUCATION

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Purpose

The purpose of this document is to communicate the required Career and Technical Education (CTE) academic standards for the Automotive Collision Repair and Refinishing Program of Study. The academic standards in this document are theoretical and performance based. The standards contain content from multiple state departments of education, industry related resources and have been reviewed and vetted by members of the Maryland business and industry community.

In addition to academic standards, the Maryland State Department of Education (MSDE) has incorporated into this document Labor Market Information (LMI) definitions and explanations for the Program of Study; program aligned Industry Recognized Credentials; and Work-Based Learning resources and requirements by course level.

Standards Sources

The following sources collectively support a progression of standards from foundational to advanced Automotive Collision Repair and Refinishing concepts in a high school context, preparing students for industry-aligned certifications like ASE Entry Level Certifications, OSHA 10/30, and EPA, with the necessary knowledge and skills for career readiness in Automotive Collision Repair and Refinishing careers.

Here are the key standards sources for Automotive Collision Repair and Refinishing curriculum:

1. **ASE Education Foundation Standards**
    A. **Description**: The National Institute for Automotive Service Excellence (ASE) develops and maintains standards for automotive education programs, including detailed task lists and program requirements.
    B. **Usage**: The ASE Education Foundation standards provide the primary framework for automotive education programs, detailing specific tasks students must master at different levels (MLR, AST, MAST). They include required hours, instructor qualifications, facility requirements, and tool/equipment specifications. These standards ensure programs meet industry needs and prepare students for ASE certification. Teachers can use the task lists to develop curriculum, create assessments, and track student progress. The standards also help in designing lab activities and determining necessary equipment.
    C. **Source**: www.ASEeducationfoundation.org

2. **I-CAR Academy**
    A. **Description**: The ICAR Academy prepares students using the latest industry techniques and standards. This is an online curriculum available for purchases for Collision and Refinishing programs.
    B. **Usage**: This program utilizes I-CAR Academy curriculum as the primary instructional resource, delivering content through a blend of online modules, hands-on demonstrations, and laboratory practice. Instructors use I-CAR's learning management system to assign foundational content that students complete before hands-on practice, allowing classroom time to focus on skill development and mastery. Each course integrates relevant I-CAR modules that align with the ASE tasks being taught, while laboratory activities follow I-CAR procedural guides and documentation standards.
    C. **Source**: https://www.i-car.com/academy

Course Descriptions

Course Level	Course Information	Description
Core: Course 1	Introduction to Collision Repair SCED: <XX> Grades: 9-12 Prerequisite: None Credit: 1	This foundational course introduces students to essential collision repair concepts and safety practices. Students will master workplace safety procedures, learn to identify different types of vehicle construction and materials, perform basic panel repairs, and develop fundamental damage analysis skills. Through hands-on experience with tool identification, personal protective equipment usage, and basic repair techniques, students build the essential knowledge required for advanced coursework in collision repair. The course emphasizes understanding safety protocols, environmental regulations, and basic repair planning while introducing students to industry-standard documentation procedures.
Core: Course 2	Non-Structural Repair & Welding SCED: <XX> Grades: 10-12 Prerequisite: None Credit: 1	Building upon foundational knowledge, this course focuses on advanced panel repair techniques and welding procedures, directly aligning with the ASE Entry-Level Certification in Non-structural Analysis & Damage Repair. Students will master GMAW (MIG) welding, plasma cutting, and adhesive bonding while developing proficiency in complex panel repair procedures. The course covers moveable glass operations, trim removal and installation, and quality control measures. Students learn to perform repairs on both metal and plastic components, gaining hands-on experience with panel alignment, fastener selection, and structural tolerances. Special emphasis is placed on developing technical skills through practical application while maintaining industry-standard quality control procedures.
Optional Flex: Course 1	Painting and Refinishing SCED: <XX> Grades: 11-12 Prerequisite: Non-Structural Repair & Welding Credit: 1	This specialized course prepares students for the ASE Entry-Level Certification in Painting & Refinishing by providing comprehensive training in automotive refinishing procedures. Students master surface preparation, paint mixing, color matching, and application techniques while learning to operate industry-standard spray equipment. The course covers the complete refinishing process from initial surface preparation through final detailing, including masking procedures, primer application, and clear coat finishing. Students learn to identify and correct paint defects, perform color blending, and execute quality control procedures. Emphasis is placed on understanding paint chemistry, proper application techniques, and environmental compliance while developing the skills needed for professional-quality refinishing work.

Course Level	Course Information	Description
Optional Flex: Course 2	Structural Analysis & Advanced Systems SCED: <XX> Grades: 11-12 Prerequisite: Painting and Refinishing Credit: 1	This advanced course prepares students for the ASE Entry-Level Certification in Structural Analysis & Damage Repair while introducing modern vehicle technology concepts. Students learn to perform structural damage analysis, frame measuring, and advanced pulling techniques while gaining experience with ADAS (Advanced Driver Assistance Systems) and their impact on collision repair. The course covers complex structural repairs, mechanical and electrical system diagnosis, and calibration procedures for advanced vehicle systems. Students master integration procedures, advanced welding techniques, and comprehensive documentation requirements. Special emphasis is placed on understanding the relationship between structural integrity and vehicle safety systems, preparing students for the evolving challenges of modern collision repair.
Optional Flex: Course 3	Career Connected Learning I SCED: <XX> Grades: 11-12 Prerequisite: Non-Structural Repair & Welding Credit: 1	This flexible, work-based learning course introduces students to real-world applications of classroom knowledge and technical skills through on-the-job experiences and reflective practice. Students engage in career exploration, skill development, and professional networking by participating in youth apprenticeships, registered apprenticeships, pre-apprenticeships, internships, capstone projects, or other approved career-connected opportunities. Variable credit (1–3) accommodates the required on-the-job training hours and related instruction. By integrating industry standards, employability skills, and personalized learning goals, Career Connected Learning I equips students to make informed career decisions, develop a professional portfolio, and build a strong foundation for success in postsecondary education, training, or the workforce.
Optional Flex: Course 4	Career Connected Learning II SCED: <XX> Grades: 11-12 Prerequisite: Career Connected Learning I Credit: 1	Building on the foundational experiences of Career Connected Learning I, this advanced work-based learning course provides students with deeper on-the-job practice, leadership opportunities, and refined career exploration. Students continue to enhance their technical and professional skills, expanding their industry networks and aligning personal goals with evolving career interests. Variable credit (1–3) remains aligned with the required training hours and related instruction. Through elevated responsibilities and skill application, Career Connected Learning II prepares students to confidently transition into higher-level postsecondary programs, apprenticeships, or the workforce.

Dual Enrollment and Career Connected Learning Experiences Must be Aligned to the CTE Core.

Industry-Recognized Credentials and Work-Based Learning

Industry-Recognized Credentials
By the end of Non-Structural Repair and Welding: ASE Entry Level Non-Structural Analysis and Damage Repair Certification **By the end of Painting and Refinishing:** ASE Entry Level Painting and Refinishing Certification **By the end of Structural Analysis & Advanced Systems:** ASE Entry Level Structural Analysis and Damage Repair Certification **By the end of the course sequence, students may be prepared for these additional certifications:** OSHA 10/30, S/P2 (various program related certificates) *Programs following the I-CAR PDP-EE program may be eligible for additional I-CAR certificates.

Work-Based Learning Examples and Resources		
Introduction to Collision Repair **Career Awareness**	**Non-Structural Repair and Welding** **Career Preparation**	**Painting and Refinishing, Structural Analysis & Advanced Systems** **Career Preparation**
• Industry Visits • Guest Speakers • Participation in Career and Technical Student Organizations • Postsecondary Visits – Program Specific Site Tours • Mock Interviews	• All of Career Awareness plus the following: • Job Shadow • Paid and Unpaid Internships	• Paid and Unpaid Internships • Apprenticeships

Labor Market Information: Definitions and Data

Labor market information (LMI) plays a crucial role in shaping Career and Technical Education (CTE) programs by providing insights into industry demands, employment trends, and skills gaps. This data helps education leaders assess the viability of existing programs and identify opportunities for new offerings. By aligning CTE programs with real-time labor market needs, schools can better prepare students for in-demand careers and ensure that resources are effectively utilized to support pathways that lead to high-quality, sustainable employment.

Standard Occupational Code (SOC) and Aligned Industry:

Indicator	Definition	Pathway Labor Market Data
High Wage[1]	Those occupations that have a 25th percentile wage equal to or greater than the most recent MIT Living Wage Index for one adult in the state of Maryland, and/or leads to a position that pays at least the median hourly or annual wage for the DC-VA-MD-WV Metropolitan Statistical Area (MSA). *Note: A 25th percentile hourly wage of $24.74 or greater is required to meet this definition.*	**Standard Occupational Code:** 49-3021: Automotive Body and Related Repairers **Hourly Wage/Annual Salary:** 25th Percentile: $20.96/$43,590 50th Percentile: $23.45/$48,780 75th Percentile: $37.42/$77,830
High Skill	Those occupations located within the DC-VA-MD-WV Metropolitan Statistical Area (MSA) with the following education or training requirements: completion of an apprenticeship program; completion of an industry-recognized certification or credential; associate's degree, bachelor's degree, or higher.	**Typical Entry-Level Education:** While there are several organized training programs in the region, there is no formal post-secondary training necessary to enter the workforce for students who have completed this program.
In-Demand	Annual growth plus replacement, across all Maryland occupations, is 405 openings between 2024-2029.	**Annual Openings**

[1] Living Wage Calculator: https://livingwage.mit.edu/states/24

Labor Market Information Data Source

Lightcast Q4 2024 Data Set. Lightcast occupation employment data are based on final Lightcast industry data and final Lightcast staffing patterns. Wage estimates are based on Occupational Employment Statistics (QCEW and Non-QCEW Employees classes of worker) and the American Community Survey (Self-Employed and Extended Proprietors). Occupational wage estimates are also affected by county-level Lightcast earnings by industry. Foundational data for the state of Maryland is collected and reported by the Maryland Department of Labor.

Methodology for High Wage Calculations

To combine labor market data across multiple Standard Occupational Classifications (SOCs), a weighted average approach was used to ensure accurate representation of the marketplace. Median wages for each SOC were weighted based on their respective employment levels, reflecting the relative demand for each occupation. This method ensures that occupations with higher employment contribute proportionately to the overall wage calculation. Additionally, job openings from all relevant SOCs were summed to determine the total projected demand. For example, if Mechanical Engineers account for 67% of total employment and Electrical Engineers for 33%, their respective wages are weighted accordingly, and job openings are aggregated to provide a comprehensive view of labor market opportunities. This approach delivers a balanced and accurate representation of both wages and employment demand for the program.

Methodology for In-Demand Calculations

The baseline for annual job openings, taking into account new positions and replacement positions, was determined by taking the average of all annual job openings between 2024 and 2029 across all 797 career sectors at the 5-digit SOC code level. For the 2024-2029 period, average job openings (growth + replacement) is 405.

Course Standards: Introduction to Collision Repair

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 9-12.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Supply Chain & Transportation Career Cluster encompasses the transfer, coordination, and management of goods from production to consumption, ensuring efficient movement across various modes of transportation including air, ground, and water, as well as Collision Repair and Refinishing of the respective transport modes. This Cluster integrates logistics and distribution networks to facilitate the seamless flow of materials and products, playing a crucial role in global commerce, economic development, and community health.
   C. The Automotive Collision and Repair program prepares students for careers in the automotive collision industry through a four-course sequence combining hands-on skills with technical knowledge. Students' progress from foundational safety and repair principles through advanced structural analysis and modern vehicle systems. Throughout the program, students master essential skills including metal straightening, welding, refinishing techniques, and structural repairs while gaining experience with industry-standard tools and equipment. Students learn to analyze damage, write estimates, repair panels, apply primers and paints, and work with advanced driver assistance systems (ADAS). The program aligns with ASE Education Foundation Entry-Level certifications: Non-structural Analysis & Damage Repair, Painting & Refinishing, and Structural Analysis & Damage Repair. Additionally, systems who use the I-CAR PDP-EE Curriculum may also earn ICAR Platinum ProLevel 1 credentials. These certifications position students for immediate employment in collision centers, dealerships, or custom shops, or continued education in advanced automotive programs.
   D. The Introduction to Collision Repair course introduces students to essential collision repair concepts and safety practices. Students will master workplace safety procedures, learn to identify different types of vehicle construction and materials, perform basic panel repairs, and develop fundamental damage analysis skills. Through hands-on experience with tool identification, personal protective equipment usage, and basic repair techniques, students build the essential knowledge required for advanced coursework in collision repair. The course emphasizes understanding safety protocols, environmental regulations, and basic repair planning while introducing students to industry-standard documentation procedures.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**
   A. The student demonstrates the necessary skills for career development, Collision Repair and Refinishing of employability, and successful completion of course outcomes. The student is expected to:
      1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, Collision Repair and Refinishing of a clean and safe work environment, and pride in work.
      2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
      3. Employ effective reading, writing, and technical documentation skills.

4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
5. Demonstrate leadership skills and collaborate effectively as a team member.
6. Implement safety procedures, including proper handling of hardware and following OSHA guidelines.
7. Exhibit an understanding of legal and ethical responsibilities in the automotive Collision Repair and Refinishing field, following applicable laws and best practices for safety.
8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. The student identifies various career pathways in the Automotive Collision Repair and Refinishing field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles as a technician or in the Automotive Collision Repair and Refinishing field.
2. Create a professional resume and portfolio that reflects skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in the Automotive Collision Repair and Refinishing field.

C. The student identifies the issues associated with Automotive Collision Repair and Refinishing hazards found on a jobsite. The student is expected to:

1. Demonstrate safe working procedures in a lab/shop environment.
2. Explain the purpose of the Occupational Safety and Health Administration (OSHA) and how it promotes safety on the job.
3. Identify Automotive Collision Repair and Refinishing related workplace hazards and how to avoid or minimize them.
4. Explain safety issues concerning lockout and tagout procedures, personal protection using assured grounding and isolation programs, automotive lift safety, and other equipment related safety protocols.

D. The student integrates core academic skills into Automotive Collision Repair and Refinishing practices. The student is expected to:

1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
2. Apply core mathematical skills including unit conversion between SAE and metric measurements, ratio and proportion calculations for material mixing, and basic geometric analysis of panel contours. Students apply linear measurement skills for damage assessment, utilize fractions and decimals in precise tool calibration, and employ basic algebraic formulas for initial damage estimates. The course emphasizes dimensional analysis, spatial reasoning, and quantitative measurement skills that form the basis for advanced repair calculations.
3. Become familiar basic materials science, focusing on the molecular structure and properties of metals, polymers, and composites used in vehicle construction. Students explore fundamental chemistry through the study of chemical bonding in primers and fillers, oxidation processes, and solvent interactions. Physics concepts include force vectors in collision dynamics, mechanical advantage principles in tool operation, and thermal expansion/contraction in metalworking. Basic electrical theory covers voltage, resistance, and grounding principles essential for tool and equipment operation. Students also examine fundamental principles of corrosion and chemical reactions in surface preparation processes.

E. The student demonstrates understanding of workplace safety and environmental procedures. The student is expected to:

1. Analyze personal and environmental safety practices associated with clothing, eye protection, hand tools, power equipment, and proper ventilation. [DAECS-D1-2, CF-D1-5]

2. Evaluate procedures for handling and disposing of hazardous and volatile materials. [PR-A1-7, CF-D1-2]
3. Select appropriate personal protective equipment for workplace activities. [PR-A1, CF-D1, DAECS-D7]
4. Implement safety procedures for handling, storing, and disposing of chemicals according to regulations. [PR-A2-3, CF-D2-3]
5. Demonstrate proper use of safety equipment and procedures in the shop environment. [PR-A4-5, CF-D4-5]

F. The student understands vehicle construction and material composition. The student is expected to:

1. Identify different types of vehicle construction (unibody, body-over-frame). [DAECS-C1-2, NS-A2]
2. Analyze different types and strengths of vehicle materials (steel, aluminum, plastic, composites). [DAECS-C3-4, NS-E1-2]
3. Explain the characteristics of various materials used in vehicle construction. [NS-E1-4, DAECS-C4]
4. Differentiate between structural and non-structural components. [DAECS-C1-5, SA-B1-2]
5. Evaluate the repairability of different materials and components. [NS-E1-2, DAECS-C4]

G. The student performs basic panel repair procedures. The student is expected to:

1. Demonstrate proper metal straightening techniques. [NS-C1-5, CF-I1-3]
2. Apply appropriate body filler materials and techniques. [NS-C6-8, CF-I4-6]
3. Execute basic plastic repair procedures. [NS-E1-4, CF-K1-4]
4. Perform panel removal and installation following manufacturer specifications. [NS-B1-5, CF-H1-4]
5. Implement proper surface preparation techniques. [PR-B1-5, CF-E1-5]

H. The student conducts damage analysis and estimating procedures. The student is expected to:

1. Identify types and extent of vehicle damage. [DAECS-A1-3, CF-A1-3]
2. Document vehicle damage using industry-standard procedures. [DAECS-A4-7, CF-A4-5]
3. Create basic damage repair plans. [DAECS-B1-3, CF-B1-3]
4. Select appropriate repair methods based on damage analysis. [DAECS-A8-10, CF-A6-7]
5. Apply proper documentation procedures for parts and materials. [DAECS-B4-6, CF-B4-5]

Course Standards: Non-Structural Repair & Welding

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 10-12.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Supply Chain & Transportation Career Cluster encompasses the transfer, coordination, and management of goods from production to consumption, ensuring efficient movement across various modes of transportation including air, ground, and water, as well as Collision Repair and Refinishing of the respective transport modes. This Cluster integrates logistics and distribution networks to facilitate the seamless flow of materials and products, playing a crucial role in global commerce, economic development, and community health.
   C. The Automotive Collision and Repair program prepares students for careers in the automotive collision industry through a four-course sequence combining hands-on skills with technical knowledge. Students progress from foundational safety and repair principles through advanced structural analysis and modern vehicle systems. Throughout the program, students master essential skills including metal straightening, welding, refinishing techniques, and structural repairs while gaining experience with industry-standard tools and equipment. Students learn to analyze damage, write estimates, repair panels, apply primers and paints, and work with advanced driver assistance systems (ADAS). The program aligns with ASE Education Foundation Entry-Level certifications: Non-structural Analysis & Damage Repair, Painting & Refinishing, and Structural Analysis & Damage Repair. Additionally, systems who use the I-CAR PDP-EE Curriculum may also earn ICAR Platinum ProLevel 1 credentials. These certifications position students for immediate employment in collision centers, dealerships, or custom shops, or continued education in advanced automotive programs.
   D. The Non-Structural Repair and Welding course focuses on advanced panel repair techniques and welding procedures, directly aligning with the ASE Entry-Level Certification in Non-structural Analysis & Damage Repair. Students will become familiar with GMAW (MIG) welding, plasma cutting, and adhesive bonding while developing proficiency in complex panel repair procedures. The course covers moveable glass operations, trim removal and installation, and quality control measures. Students learn to perform repairs on both metal and plastic components, gaining hands-on experience with panel alignment, fastener selection, and structural tolerances. Special emphasis is placed on developing technical skills through practical application while maintaining industry-standard quality control procedures.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**
   A. The student demonstrates the necessary skills for career development, Collision Repair and Refinishing of employability, and successful completion of course outcomes. The student is expected to:
      1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, Collision Repair and Refinishing of a clean and safe work environment, and pride in work.

2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
3. Employ effective reading, writing, and technical documentation skills.
4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
5. Demonstrate leadership skills and collaborate effectively as a team member.
6. Implement safety procedures, including proper handling of hardware and following OSHA guidelines.
7. Exhibit an understanding of legal and ethical responsibilities in the automotive field, following applicable laws and best practices for safety.
8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. The student identifies various career pathways in the Automotive Collision Repair and Refinishing field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles as a technician or in the Automotive Collision Repair and Refinishing field.
2. Create a professional resume and portfolio that reflects skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in the Automotive Collision Repair and Refinishing field.

C. The student identifies the issues associated with Automotive Collision Repair and Refinishing hazards found on a jobsite. The student is expected to:

1. Demonstrate safe working procedures in a lab/shop environment.
2. Explain the purpose of the Occupational Safety and Health Administration (OSHA) and how it promotes safety on the job.
3. Identify Automotive Collision Repair and Refinishing related workplace hazards and how to avoid or minimize them.
4. Explain safety issues concerning lockout and tagout procedures, personal protection using assured grounding and isolation programs, automotive lift safety, and other equipment related safety protocols.

D. The student integrates core academic skills into Automotive Collision Repair and Refinishing practices. The student is expected to:

1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
2. Apply geometric principles in panel alignment and structural measurements. Students utilize trigonometric functions for angular measurements in welding positions, apply Pythagorean theorem in panel alignment, and perform advanced ratio calculations for material thickness and penetration depth. The coursework incorporates basic statistical concepts for quality control measurements, including mean, tolerance ranges, and standard deviation. Students develop proficiency in three-dimensional measurements, spatial relationships, and advanced estimation techniques for multi-stage repair procedures.
3. Explore metallurgical principles and thermodynamics in welding processes. Students examine crystalline structures of metals, phase transformations during heating and cooling, and the physics of heat transfer through conduction and radiation. The chemistry of metal oxidation, gas shielding principles in welding, and electrochemical reactions in corrosion protection are explored in depth. Students apply gas laws and pressure relationships in plasma cutting operations, while studying electrical theory in welding operations, including current flow, resistance, and circuit characteristics. Material science expands to include stress/strain relationships, work hardening phenomena, and metal fatigue principles.

E. The student demonstrates proficiency in welding and joining techniques. The student is expected to:

1. Perform GMAW (MIG) welding procedures on various materials. [WE-A2-5, NS-E7]
2. Execute proper plasma cutting techniques. [WE-A16]
3. Apply adhesive bonding procedures according to manufacturer specifications. [NS-E8-10]
4. Demonstrate squeeze-type resistance spot welding techniques. [WE-A17]
5. Evaluate weld quality using destructive and non-destructive testing methods. [WE-A13-14]

F. The student masters advanced panel repair techniques. The student is expected to:

1. Perform complex metal finishing procedures. [NS-C1-3]
2. Apply advanced body filling techniques. [NS-C6-8]
3. Execute comprehensive plastic repair procedures. [NS-E3-6]
4. Demonstrate proper panel alignment methods. [NS-B4-7]
5. Implement quality control measures throughout repair processes. [NS-B11-12]

G. The student performs trim and hardware operations. The student is expected to:

1. Remove and install moveable glass components. [NS-D1-2]
2. Execute interior trim removal and installation. [NS-A4]
3. Perform exterior trim removal and installation. [NS-A3]
4. Demonstrate proper panel adjustment techniques. [NS-B1-3]
5. Apply appropriate fastening methods for different components. [NS-B8-10]

H. The student implements quality control procedures. The student is expected to:

1. Utilize proper inspection techniques. [DAECS-A1-5]
2. Perform accurate measurements using precision instruments. [SA-A1]
3. Create detailed documentation of repair procedures. [DAECS-B1-5]
4. Analyze repair quality using industry standards. [NS-B11-12]
5. Develop solutions for common repair issues. [NS-B13-15]

Course Standards: Painting and Refinishing

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 10-12.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Supply Chain & Transportation Career Cluster encompasses the transfer, coordination, and management of goods from production to consumption, ensuring efficient movement across various modes of transportation including air, ground, and water, as well as Collision Repair and Refinishing of the respective transport modes. This Cluster integrates logistics and distribution networks to facilitate the seamless flow of materials and products, playing a crucial role in global commerce, economic development, and community health.
   C. The Automotive Collision and Repair program prepares students for careers in the automotive collision industry through a four-course sequence combining hands-on skills with technical knowledge. Students progress from foundational safety and repair principles through advanced structural analysis and modern vehicle systems. Throughout the program, students master essential skills including metal straightening, welding, refinishing techniques, and structural repairs while gaining experience with industry-standard tools and equipment. Students learn to analyze damage, write estimates, repair panels, apply primers and paints, and work with advanced driver assistance systems (ADAS). The program aligns with ASE Education Foundation Entry-Level certifications: Non-structural Analysis & Damage Repair, Painting & Refinishing, and Structural Analysis & Damage Repair. Additionally, systems who use the I-CAR PDP-EE Curriculum may also earn ICAR Platinum ProLevel 1 credentials. These certifications position students for immediate employment in collision centers, dealerships, or custom shops, or continued education in advanced automotive programs.
   D. This specialized course prepares students for the ASE Entry-Level Certification in Painting & Refinishing by providing comprehensive training in automotive refinishing procedures. Students master surface preparation, paint mixing, color matching, and application techniques while learning to operate industry-standard spray equipment. The course covers the complete refinishing process from initial surface preparation through final detailing, including masking procedures, primer application, and clear coat finishing. Students learn to identify and correct paint defects, perform color blending, and execute quality control procedures. Emphasis is placed on understanding paint chemistry, proper application techniques, and environmental compliance while developing the skills needed for professional-quality refinishing work.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**
   A. The student demonstrates the necessary skills for career development, Collision Repair and Refinishing of employability, and successful completion of course outcomes. The student is expected to:
      1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, Collision Repair and Refinishing of a clean and safe work environment, and pride in work.
      2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
      3. Employ effective reading, writing, and technical documentation skills.

4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
5. Demonstrate leadership skills and collaborate effectively as a team member.
6. Implement safety procedures, including proper handling of hardware and following OSHA guidelines.
7. Exhibit an understanding of legal and ethical responsibilities in the Automotive Collision Repair and Refinishing field, following applicable laws and best practices for safety.
8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. The student identifies various career pathways in the Automotive Collision Repair and Refinishing field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles as a technician or in the Automotive Collision Repair and Refinishing field.
2. Create a professional resume and portfolio that reflects skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in the Automotive Collision Repair and Refinishing field.

C. The student identifies the issues associated with Automotive Collision Repair and Refinishing hazards found on a jobsite. The student is expected to:

1. Demonstrate safe working procedures in a lab/shop environment.
2. Explain the purpose of the Occupational Safety and Health Administration (OSHA) and how it promotes safety on the job.
3. Identify Automotive Collision Repair and Refinishing related workplace hazards and how to avoid or minimize them.
4. Explain safety issues concerning lockout and tagout procedures, personal protection using assured grounding and isolation programs, automotive lift safety, and other equipment related safety protocols.

D. The student integrates core academic skills into Automotive Collision Repair and Refinishing practices. The student is expected to:

1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
2. Calculate mixing ratios, volumetric calculations, and surface area determinations. Students apply geometric formulas for complex surface areas, utilize ratio and proportion in paint mixing formulas, and perform viscosity calculations. Environmental calculations include relative humidity, temperature conversions, and dew point determinations. The course incorporates advanced measurement systems for film build calculations, mixing ratios for multi-stage finishes, and coverage rate determinations. Statistical analysis is applied to color matching and quality control procedures.
3. Understand chemistry of coatings technology, including polymer chemistry, cross-linking reactions, and solvent evaporation principles. Students explore advanced concepts in fluid dynamics through spray atomization physics, surface tension principles, and viscosity relationships. Light theory and color physics become essential in understanding spectrophotometry, metameric effects, and color matching principles. Environmental science concepts include psychrometrics, vapor pressure relationships, and VOC emissions chemistry. Students examine reaction kinetics in paint curing, adhesion theory in coating applications, and surface chemistry in substrate preparation.

E. The student masters surface preparation techniques. The student is expected to:

1. Perform proper chemical cleaning procedures. [PR-B2-4]
2. Execute appropriate sanding techniques. [PR-B6-8]
3. Demonstrate masking procedures for various applications. [PR-B9-10]

4. Apply primer according to manufacturer specifications. [PR-B11-14]
5. Evaluate surface quality before refinishing. [PR-B15-17]

F. The student demonstrates proficiency in paint application. The student is expected to:

1. Operate spray equipment according to manufacturer specifications. [PR-C1-3]
2. Mix paint materials following proper procedures. [PR-D1-3]
3. Perform color matching techniques. [PR-D12-15]
4. Execute blending procedures. [PR-D6-7]
5. Apply clear coat according to manufacturer specifications. [PR-D8-9]

G. The student identifies and corrects paint problems. The student is expected to:

1. Diagnose common paint defects. [PR-E1-5]
2. Implement appropriate correction techniques. [PR-E6-10]
3. Develop strategies for preventing paint problems. [PR-E11-15]
4. Perform paint material tests. [PR-E16-20]
5. Evaluate final finish quality. [PR-E21-26]

H. The student performs final detailing procedures. The student is expected to:

1. Execute buffing and polishing techniques. [PR-F2-3]
2. Conduct final quality inspections. [PR-F7]
3. Prepare vehicles for customer delivery. [PR-F4-5]
4. Document final quality control measures. [PR-F8]
5. Demonstrate proper care and maintenance procedures. [PR-F6,9]

Course Standards: Structural Analysis & Advanced Systems

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 11-12.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Supply Chain & Transportation Career Cluster encompasses the transfer, coordination, and management of goods from production to consumption, ensuring efficient movement across various modes of transportation including air, ground, and water, as well as Collision Repair and Refinishing of the respective transport modes. This Cluster integrates logistics and distribution networks to facilitate the seamless flow of materials and products, playing a crucial role in global commerce, economic development, and community health.
   C. The Automotive Collision and Repair program prepares students for careers in the automotive collision industry through a four-course sequence combining hands-on skills with technical knowledge. Students progress from foundational safety and repair principles through advanced structural analysis and modern vehicle systems. Throughout the program, students master essential skills including metal straightening, welding, refinishing techniques, and structural repairs while gaining experience with industry-standard tools and equipment. Students learn to analyze damage, write estimates, repair panels, apply primers and paints, and work with advanced driver assistance systems (ADAS). The program aligns with ASE Education Foundation Entry-Level certifications: Non-structural Analysis & Damage Repair, Painting & Refinishing, and Structural Analysis & Damage Repair. Additionally, systems who use the I-CAR PDP-EE Curriculum may also earn ICAR Platinum ProLevel 1 credentials. These certifications position students for immediate employment in collision centers, dealerships, or custom shops, or continued education in advanced automotive programs.
   D. This advanced course prepares students for the ASE Entry-Level Certification in Structural Analysis & Damage Repair while introducing modern vehicle technology concepts. Students learn to perform structural damage analysis, frame measuring, and advanced pulling techniques while gaining experience with ADAS (Advanced Driver Assistance Systems) and their impact on collision repair. The course covers complex structural repairs, mechanical and electrical system diagnosis, and calibration procedures for advanced vehicle systems. Students master integration procedures, advanced welding techniques, and comprehensive documentation requirements. Special emphasis is placed on understanding the relationship between structural integrity and vehicle safety systems, preparing students for the evolving challenges of modern collision repair.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**
   A. The student demonstrates the necessary skills for career development, Collision Repair and Refinishing of employability, and successful completion of course outcomes. The student is expected to:
      1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, Collision Repair and Refinishing of a clean and safe work environment, and pride in work.

2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
3. Employ effective reading, writing, and technical documentation skills.
4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
5. Demonstrate leadership skills and collaborate effectively as a team member.
6. Implement safety procedures, including proper handling of hardware and following OSHA guidelines.
7. Exhibit an understanding of legal and ethical responsibilities in the Automotive Collision Repair and Refinishing field, following applicable laws and best practices for safety.
8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. The student identifies various career pathways in the Automotive Collision Repair and Refinishing field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles as a technician or in the Automotive Collision Repair and Refinishing field.
2. Create a professional resume and portfolio that reflects skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in the Automotive Collision Repair and Refinishing field.

C. The student identifies the issues associated with Automotive Collision Repair and Refinishing hazards found on a jobsite. The student is expected to:

1. Demonstrate safe working procedures in a lab/shop environment.
2. Explain the purpose of the Occupational Safety and Health Administration (OSHA) and how it promotes safety on the job.
3. Identify Automotive Collision Repair and Refinishing related workplace hazards and how to avoid or minimize them.
4. Explain safety issues concerning lockout and tagout procedures, personal protection using assured grounding and isolation programs, automotive lift safety, and other equipment related safety protocols.

D. The student integrates core academic skills into Automotive Collision Repair and Refinishing practices. The student is expected to:

1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
2. Apply vector analysis for collision forces, three-dimensional geometry for frame measurements, and complex trigonometric calculations for structural alignment. Students apply analytical geometry in frame measurement, vector mathematics in force analysis, and advanced algebraic formulas in steering geometry calculations. Electronic system diagnostics incorporate Ohm's Law calculations, voltage drop analysis, and resistance calculations. Statistical process control methods are employed in quality assurance procedures, while advanced estimating requires compound calculations involving multiple variables.
3. Focus on advanced physics concepts in structural dynamics, electronic theory in vehicle systems, and materials science in modern composites. Students analyze energy management principles in crash dynamics, electronic signal processing in sensor operations, and strain gauge theory in measuring equipment. The course covers advanced concepts in hydraulics and pneumatics, including Pascal's Law, pressure relationships, and fluid dynamics. Electrical theory expands to include semiconductor principles, digital logic operations, and sensor calibration physics. Materials science concepts address high-strength steel metallurgy, composite material behavior, and advanced joining technology principles.

E. The student performs structural analysis and repair procedures. The student is expected to:

1. Utilize frame measuring equipment. [SA-A1-3]
2. Analyze structural damage patterns. [SA-A3-7]
3. Create comprehensive repair plans. [SA-B6]
4. Execute proper anchoring and pulling techniques. [SA-B7-12]
5. Evaluate repair quality using measurement data. [SA-B13-15]

F. The student demonstrates understanding of advanced vehicle systems. The student is expected to:

1. Diagnose ADAS system operations. [ME-I1-5]
2. Perform electrical system diagnostics. [ME-B1-5]
3. Analyze mechanical system functions. [ME-C1-5]
4. Execute calibration procedures. [ME-I1-5]
5. Evaluate system operation after repair. [ME-I3-5]

G. The student performs complex structural repairs. The student is expected to:

1. Execute frame repair procedures. [SA-A8-11]
2. Perform unibody repair techniques. [SA-B8-12]
3. Demonstrate advanced welding applications. [WE-A12-15]
4. Replace structural components following manufacturer specifications. [SA-B13-16]
5. Implement proper corrosion protection measures. [SA-B17-19]

H. The student masters integration and documentation procedures. The student is expected to:

1. Conduct comprehensive quality control inspections. [DAECS-B21-23]
2. Create detailed repair documentation. [DAECS-A16-20]
3. Perform customer service procedures. [DAECS-D1-6]
4. Evaluate repair outcomes against manufacturer specifications. [DAECS-B20-22]
5. Develop solutions for complex repair issues. [DAECS-D7-12]

Course Standards: Career Connected Learning I and II

Career connected learning is an educational approach that integrates classroom instruction with real-world experiences, enabling high school students to explore potential careers and develop relevant skills before graduation. By participating in work-based learning opportunities—such as apprenticeships, internships, capstone projects, and school-based enterprises—students apply academic concepts in authentic settings, gain practical industry knowledge, and build professional networks. This hands-on engagement helps students connect their studies to future career paths, strengthens their problem-solving and communication skills, and supports a smoother transition into college, vocational programs, or the workforce.

All Career and Technical Education Programs of Study include aspects of work-based learning, and almost all of the programs include two Career Connected Learning (CCL) courses. Below are the course descriptions for CCL I and CCL II. The CCL standards can be found via this link: