Maryland
STATE DEPARTMENT OF EDUCATION

Program of Study Guide: Automotive Maintenance - DRAFT

Comprehensive guidelines and course standards for the Automotive Maintenance 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 Maintenance 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 Maintenance concepts in a high school context, preparing students for industry-aligned certifications like ASE Entry Level Certifications, OSHA 10/30, and EPA 609, with the necessary knowledge and skills for career readiness in Automotive Maintenance careers.

Here are the key standards sources for Automotive Maintenance 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. **Society of Automotive Engineers (SAE) Standards**
    A. **Description**: Technical standards and professional development resources focused on advancing mobility engineering knowledge.
    B. **Usage**: SAE provides technical standards, research papers, and professional development resources that can enhance automotive instruction. Teachers can use SAE materials to incorporate current technology trends, engineering principles, and industry innovations into their curriculum. These resources are particularly valuable for advanced topics and emerging technologies like electric vehicles and autonomous systems. SAE materials can help students understand the engineering principles behind automotive systems.
    C. **Source**: www.sae.org

Course Descriptions

Course Level	Course Information	Description
Core: Course 1	Automotive Maintenance: Electrical Principles SCED: <XX> Grades: 9-12 Prerequisite: None Credit: 1	This foundational course introduces students to automotive electrical systems, emphasizing diagnostic and repair skills. Students will learn to use diagnostic tools like digital multimeters, analyze and repair circuits, and perform battery testing and charging. Key topics include diagnosing shorts and parasitic draws, repairing electrical components, and servicing lighting and body electrical systems.
Core: Course 2	Automotive Maintenance: Chassis Systems SCED: <XX> Grades: 10-12 Prerequisite: Automotive Maintenance: Electrical Principles Credit: 1	Students in this course will develop skills in diagnosing and repairing suspension, steering, and brake systems. They will perform tasks such as wheel alignments, tire servicing, and brake component replacement. Additional topics include inspecting suspension components, servicing power steering systems, and understanding electronic brake controls and regenerative braking.
Optional Flex: Course 1	Automotive Maintenance: Powertrain Systems SCED: <XX> Grades: 11-12 Prerequisite: Automotive Maintenance: Chassis Systems Credit: 1	This course focuses on the maintenance and repair of engines, transmissions, and drivetrain systems. Students will perform oil changes, cooling system services, and timing inspections. They will also explore manual and automatic transmission fundamentals, servicing drive shafts, and maintaining four-wheel and all-wheel drive systems.

Course Level	Course Information	Description
Optional Flex: Course 2	Career Connected Learning I SCED: <XX> Grades: 11-12 Prerequisite: Horticulture Science I and II 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 3	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 Automotive Maintenance: Electrical Principles: ASE Entry Level Electrical Certification **By the end of Automotive Maintenance: Chassis Systems:** ASE Entry Level Suspension & Steering and Brakes Certification **By the end of Automotive Maintenance: Powertrain Systems:** ASE Entry Level Engine Repair, Manual Drive Train and/or Automatic Transmission Certification **By the end of Automotive Maintenance: Vehicle Systems Integration:** ASE Entry Level Engine Performance, HVAC Certification, and Maintenance and Light Repair

Work-Based Learning Examples and Resources		
Automotive Maintenance: Electrical Principles **Career Awareness**	**Automotive Maintenance: Chassis Systems** **Career Preparation**	**Automotive Maintenance: Powertrain Systems and Vehicle 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:** 49-3023: Automotive Service Technicians **Hourly Wage/Annual Salary:** 25th Percentile: $18.89/$39,290 50th Percentile: $26.53/$55,190 75th Percentile: $34.62/$72,010
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: Automotive Maintenance: Electrical Principles

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 maintenance 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 Maintenance program is a comprehensive four-course sequence designed to prepare students for entry into the automotive technician field. This program provides a strong foundation in diagnosing, maintaining, and repairing key vehicle systems, including electrical, chassis, powertrain, and integrated systems. Students gain hands-on experience with industry-standard tools and techniques while developing critical problem-solving and technical skills. The curriculum aligns with ASE Entry Level Certification exams, ensuring students are prepared to earn industry recognized certifications at the conclusion of each course. Graduates of the program will be equipped with the knowledge and competencies needed for success in a variety of roles within the automotive repair and maintenance industry.
   D. The Automotive Maintenance: Electrical Principles course introduces students to automotive electrical systems, emphasizing diagnostic and repair skills. Students will learn to use diagnostic tools like digital multimeters, analyze and repair circuits, and perform battery testing and charging. Key topics include diagnosing shorts and parasitic draws, repairing electrical components, and servicing lighting and body electrical systems. Upon completion, students will be prepared to pursue the ASE Entry-Level Certification in Electrical/Electronic Systems.
   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, maintenance 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, maintenance 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 maintenance 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 Maintenance 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 Maintenance 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 Maintenance field.

C. The student identifies the issues associated with Automotive Maintenance 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 Maintenance 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 Maintenance 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 voltage drops across circuits, measure electrical resistance using Ohm's Law, and analyze current flow within automotive electrical systems. They will use algebra to troubleshoot electrical faults and perform computations for battery capacity and power output.
3. Study the flow of electricity, exploring how electrons move through conductors and resistors. They will apply concepts of electromagnetism to understand how alternators generate power and how relays and solenoids operate. Additionally, they will investigate how environmental factors, such as temperature, affect electrical performance.

E. The student understands general electrical system fundamentals and diagnostic procedures. The student is expected to:

1. Research and apply vehicle service information, including system configurations, technical service bulletins, and recalls.
2. Demonstrate proper use of diagnostic tools and procedures, including:
   i) Using digital multimeters for measuring voltage, current flow, and resistance.

ii) Testing circuits using wiring diagrams.
iii) Using fused jumper wires.
iv) Testing fusible links, circuit breakers, and fuses.
3. Apply electrical principles to analyze shorts, grounds, opens, and resistance problems.
4. Measure and diagnose key-off battery drain (parasitic draw).
5. Repair and replace electrical system components, including connectors, terminal ends, and wiring.

F. The student understands battery diagnosis and service (Low Voltage). The student is expected to:

1. Perform battery testing procedures, including:
   i) State-of-charge testing.
   ii) Capacity and load testing.
   iii) Proper charging procedures.
2. Inspect and clean battery components, including cables, connectors, clamps, and hold-downs.
3. Perform safe jump-starting procedures using jumper cables and booster batteries.
4. Maintain and restore electronic memory functions.

G. The student understands starting system diagnosis and repair (Low Voltage). The student is expected to:

1. Perform starter system tests, including:
   i) Current draw testing.
   ii) Circuit voltage drop testing.
2. Inspect and test starter system components including:
   i) Relays and solenoids.
   ii) Switches, connectors, and wires.
3. Demonstrate knowledge of automatic idle-stop/start-stop systems.

H. The student understands charging system diagnosis and repair (Low Voltage). The student is expected to:

1. Perform charging system output testing.
2. Inspect, adjust, and replace generator drive belts, checking:
   i) Pulleys and tensioners for wear.
   ii) Pulley and belt alignment.
3. Perform charging circuit voltage drop tests.
4. Remove, inspect, and replace generator (alternator).

I. The student understands lighting systems and related components. The student is expected to:

1. Inspect and replace interior and exterior lighting components, including:
   i) Headlights and auxiliary lights.
   ii) Bulbs and sockets.
2. Perform headlight aiming procedures.

J. The student understands instrument cluster and driver information systems. The student is expected to:

1. Verify operation of instrument panel gauges and warning/indicator lights.

2. Reset maintenance indicators as required.

K. The student understands basic body electrical systems. The student is expected to:

1. Remove and reinstall door panels.
2. Verify windshield wiper and washer operation and replace wiper blades.
3. Describe operation of keyless entry/remote-start systems.
4. Describe disabling and enabling procedures for supplemental restraint systems (SRS).

Course Standards: Automotive Maintenance: Chassis Systems

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 maintenance 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 Maintenance program is a comprehensive four-course sequence designed to prepare students for entry into the automotive technician field. This program provides a strong foundation in diagnosing, maintaining, and repairing key vehicle systems, including electrical, chassis, powertrain, and integrated systems. Students gain hands-on experience with industry-standard tools and techniques while developing critical problem-solving and technical skills. The curriculum aligns with ASE Entry Level Certification exams, ensuring students are prepared to earn industry recognized certifications at the conclusion of each course. Graduates of the program will be equipped with the knowledge and competencies needed for success in a variety of roles within the automotive repair and maintenance industry.
   D. Students in Automotive Maintenance: Chassis Systems course will develop skills in diagnosing and repairing suspension, steering, and brake systems. They will perform tasks such as wheel alignments, tire servicing, and brake component replacement. Additional topics include inspecting suspension components, servicing power steering systems, and understanding electronic brake controls and regenerative braking. Successful students will be equipped to pursue the ASE Entry-Level Certification in Brakes and/or Steering and Suspension.
   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, maintenance 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, maintenance 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 Maintenance 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 Maintenance 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 Maintenance field.

C. The student identifies the issues associated with Automotive Maintenance 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 Maintenance 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 Maintenance 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. Perform calculations related to wheel alignment, such as determining camber, caster, and toe angles, and analyze tire wear patterns based on alignment data. They will also measure brake component wear, calculate hydraulic pressures in braking systems, and determine proper torque specifications for chassis components.
3. Explore the principles of friction and its role in braking systems, the dynamics of suspension systems as they respond to vehicle loads and road conditions, and the mechanics of steering. They will also apply concepts of hydraulics to understand power steering and brake fluid operation.

E. The student understands general suspension, steering, and brake system fundamentals. The student is expected to:

1. Research and apply vehicle service information, including technical service bulletins and recalls.
2. Identify suspension, steering, and brake system components and configurations.

3. Disable and enable supplemental restraint system (SRS) components during vehicle service.
4. Retrieve and record diagnostic trouble codes.

F. The student understands steering systems diagnosis and repair. The student is expected to:

1. Inspect and diagnose steering system components, including:
   i) Rack and pinion steering gear
   ii) Tie rod ends and bellows boots
2. Perform power steering system service, including:
   i) Fluid level inspection
   ii) System bleeding
   iii) Drive belt inspection and replacement
3. Inspect steering system components for wear and damage
4. Demonstrate knowledge of electric power steering system operation

G. The student understands suspension systems diagnosis and repair. The student is expected to:

1. Inspect suspension components, including:
   i) Control arms and bushings.
   ii) Springs and insulators.
   iii) Stabilizer bars and bushings.
   iv) Strut assemblies.
2. Diagnose suspension system concerns.
3. Remove and replace suspension components as needed.
4. Verify proper suspension system operation.

H. The student understands wheel alignment and tire service. The student is expected to:

1. Perform pre-alignment inspection procedures.
2. Describe alignment angles and their effects on vehicle handling.
3. Perform tire inspection, rotation, and balancing.
4. Diagnose tire wear patterns and vibration concerns.
5. Service tire pressure monitoring systems (TPMS).

I. The student understands brake system diagnosis and repair. The student is expected to:

1. Inspect brake system components for wear and damage.
2. Measure brake component wear using appropriate tools.
3. Service disc brake systems, including:
   i) Caliper assembly inspection and service.
   ii) Rotor inspection and service.
   iii) Brake pad replacement.
4. Service drum brake systems, including:
   i) Drum inspection and measurement.
   ii) Hardware inspection and replacement.
   iii) Brake shoe replacement.
5. Perform brake hydraulic system service, including:
   i) Fluid level inspection.
   ii) System bleeding.

iii) Line and hose inspection.

J. The student understands power assist units and related systems. The student is expected to:

1. Check brake pedal travel with and without engine running.
2. Identify brake power assist system components.
3. Service parking brake system components.

K. The student understands brake-related electronic systems. The student is expected to:

1. Identify electronic brake control system components.
2. Verify operation of brake warning light systems.
3. Describe operation of regenerative braking systems.

Course Standards: Automotive Maintenance: Powertrain 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 maintenance 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 Maintenance program is a comprehensive four-course sequence designed to prepare students for entry into the automotive technician field. This program provides a strong foundation in diagnosing, maintaining, and repairing key vehicle systems, including electrical, chassis, powertrain, and integrated systems. Students gain hands-on experience with industry-standard tools and techniques while developing critical problem-solving and technical skills. The curriculum aligns with ASE Entry Level Certification exams, ensuring students are prepared to earn industry recognized certifications at the conclusion of each course. Graduates of the program will be equipped with the knowledge and competencies needed for success in a variety of roles within the automotive repair and maintenance industry.
   D. The Automotive Maintenance: Powertrain Systems course focuses on the maintenance and repair of engines, transmissions, and drivetrain systems. Students will perform oil changes, cooling system services, and timing inspections. They will also explore manual and automatic transmission fundamentals, servicing drive shafts, and maintaining four-wheel and all-wheel drive systems. Completion of this course aligns with preparation for the ASE Entry-Level Certification in Engine Repair and/or Automatic Transmission/Transaxle.
   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, maintenance 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, maintenance 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 Maintenance 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 Maintenance 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 Maintenance 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 Maintenance field.

C. The student identifies the issues associated with Automotive Maintenance 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 Maintenance 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 Maintenance 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. Compute gear ratios to analyze torque transfer in manual and automatic transmissions, calculate engine timing intervals, and measure fluid levels for cooling and lubrication systems. They will also evaluate drivetrain angles and perform diagnostic calculations for engine performance.
3. Use scientific principles including thermodynamics, focusing on heat transfer in engine cooling systems and energy conversion in internal combustion engines. Students will study the physics of rotational motion in drivetrain components and the principles of power delivery in four-wheel and all-wheel drive systems.

E. The student understands general engine repair fundamentals. The student is expected to:

1. Research vehicle service information and specifications.
2. Verify operation of instrument panel engine warning indicators.
3. Inspect engine assembly for fluid leaks.
4. Install engine covers using appropriate gaskets and sealers.
5. Demonstrate knowledge of engine timing verification procedures.

6. Inspect engine mounts.

F. The student understands lubrication and cooling systems. The student is expected to:

1. Perform engine oil and filter changes.
2. Perform cooling system tests and service, including:
   i) Pressure testing.
   ii) Coolant condition inspection.
   iii) System bleeding.
3. Inspect and replace drive belts and tensioners.
4. Service cooling system components.

G. The student understands automatic transmission fundamentals. The student is expected to:

1. Research transmission/transaxle service information.
2. Identify transmission/transaxle components and configurations.
3. Check and adjust transmission fluid levels.
4. Inspect transmission for leaks.
5. Demonstrate knowledge of transmission power flow principles.

H. The student understands manual drivetrain fundamentals. The student is expected to:

1. Research manual drivetrain service information.
2. Identify manual drivetrain components and configurations.
3. Check fluid levels and condition.
4. Inspect and service drive shaft components.
5. Service differential components.

I. The student understands four-wheel drive/all-wheel drive systems. The student is expected to:

1. Identify transfer case and drive system components.
2. Check transfer case fluid levels.
3. Inspect drive system seals and vents.

Course Standards: Automotive Maintenance: Vehicle Systems and Integration

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 maintenance 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 Maintenance program is a comprehensive four-course sequence designed to prepare students for entry into the automotive technician field. This program provides a strong foundation in diagnosing, maintaining, and repairing key vehicle systems, including electrical, chassis, powertrain, and integrated systems. Students gain hands-on experience with industry-standard tools and techniques while developing critical problem-solving and technical skills. The curriculum aligns with ASE Entry Level Certification exams, ensuring students are prepared to earn industry recognized certifications at the conclusion of each course. Graduates of the program will be equipped with the knowledge and competencies needed for success in a variety of roles within the automotive repair and maintenance industry.
   D. The Automotive Maintenance: Systems and Integration course emphasizes diagnostic strategies across multiple vehicle systems, including computerized engine controls, emissions, and HVAC systems. Students will gain expertise in using diagnostic tools, inspecting air induction and fuel systems, and analyzing engine performance data. The course culminates in applying integrated knowledge to complex diagnostic and repair scenarios. Students will be prepared to pursue ASE Entry-Level Certifications in Engine Performance, Heating and Air Conditioning, and related systems.
   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, maintenance 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, maintenance 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 Maintenance 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 Maintenance 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 Maintenance 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 Maintenance field.

C. The student identifies the issues associated with Automotive Maintenance 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 Maintenance 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 Maintenance 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. Interpret diagnostic data, perform fuel economy calculations, and analyze emissions system efficiency using sensor outputs. They will also calculate air-to-fuel ratios and interpret HVAC pressure readings to ensure system efficiency.
3. Use scientific principles including combustion science, focusing on the properties of air and fuel mixtures and the impact of engine timing on performance. They will also explore the thermodynamics of HVAC systems, the operation of emissions controls like catalytic converters, and the physics behind electronic engine control systems, including sensor inputs and computer algorithms.

E. The student understands general engine performance fundamentals. The student is expected to:

1. Research vehicle service information and specifications.
2. Retrieve and interpret diagnostic trouble codes.
3. Demonstrate knowledge of engine cooling system operation.

4. Verify engine mechanical timing.
5. Demonstrate knowledge of variable valve timing (VVT) systems.

F. The student understands computerized engine controls. The student is expected to:

1. Identify computerized control system components.
2. Demonstrate proper use of diagnostic scan tools.
3. Monitor and analyze engine performance data.

G. The student understands fuel, air induction, and exhaust systems. The student is expected to:

1. Inspect air induction system components.
2. Service fuel system components.
3. Inspect exhaust system components.
4. Replace fuel filters.
5. Check and refill diesel exhaust fluid (DEF).

H. The student understands emissions control systems. The student is expected to:

1. Identify emissions control components.
2. Service positive crankcase ventilation (PCV) systems.

I. The student understands heating and air conditioning systems. The student is expected to:

1. Research HVAC service information and specifications.
2. Identify HVAC components and configurations.
3. Inspect HVAC system components.
4. Perform A/C performance testing.
5. Service HVAC system components.

J. The student demonstrates integration of systems knowledge. The student is expected to:

1. Diagnose complex system interactions.
2. Apply diagnostic strategies across multiple vehicle systems.
3. Demonstrate comprehensive vehicle inspection procedures.
4. Document repair procedures and outcomes.
5. Apply workplace skills in complex repair situations.

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: