Grade 12B Advanced Mechanical Systems

Course Code	8701
Course Credit	1.0

Senior Years Technology Education Program

Discipline Overview

An approved technical-vocational education (TVE) program cluster comprises departmentally developed and/or approved courses in one specific trade or trained occupation that facilitates the transition from school to either post-secondary training (such as the training provided through Apprenticeship Manitoba) or entry into the workforce (often at an entry-level position).

When learners pursue their studies in an environment modelled after the workplace, they will acquire not only trade-related skills, but will also develop

- employability skills required to make an effective transition from school to work
- an understanding of career development and planning
- an understanding of the importance of becoming autonomous, lifelong learners who can adapt their skills and knowledge to what they will need in the future
- an awareness of safety in school, in the workplace, and at home
- an awareness of sustainability as it relates to the specific skilled trade and society

Course Overview

In this course, learners will deepen their understanding of vehicle mechanical systems, building on the knowledge gained in the fundamental courses. They will focus on the detailed function and interaction of mechanical components and their impact on overall vehicle performance. Learners will continue to expand their expertise in the automotive profession, including safety practices, tools and equipment, and the selection and use of materials and consumables.

This advanced course emphasizes more complex procedures for servicing, diagnosing, repairing, and replacing mechanical systems and components. Learners will also apply advanced mathematical concepts relevant to the automotive trade, including precise measurements, tolerances, and calculations critical to system performance and repair accuracy.

This course focuses on the following units in the Apprenticeship Manitoba Level 1 technical training:

- A6 Driveline Systems I: Drive Shafts and CV Shafts
- A7 Engine Fundamentals
- A10 Steering and Suspension Systems I
- A11 Braking Systems I (Non-ABS)
- A13 Body Components, Accessories and Trim

The learning outcomes in this course may not follow a fixed sequence, as they are organized to align with Apprenticeship Manitoba standards. Only the outcomes relevant to this course are included. A complete list of learning outcomes can be found in the primary learning outcomes resource.

Global Competencies in Automotive Technology

Critical Thinking

Critical thinking in automotive technology involves the intentional process of synthesizing and analyzing ideas using criteria and evidence, making reasoned decisions and judgments, and reflecting on the outcomes and implications of those decisions and judgments.

When critical thinking as a competency is applied in automotive technology, learners

- **find and use** sources strategically, efficiently, and effectively when making safety, environment, and respectful workplace decisions and choices
- **evaluate** sources for bias, relevance, and reliability in trade communications and documents, as well as for the selection and use of materials and consumables
- analyze and synthesize ideas using **criteria and evidence** that demonstrate awareness of emerging trends and issues
- understand that people (customers) come with **varied perspectives based on their own experience**
- demonstrate **flexibility to reconsider** their thinking when faced with new credible information or resources
- enhance comprehension, clarify meaning, make connections, and expand experiences through questioning
- **make judgments** based on observation, experience, and evidence
- **weigh criteria** to apply safe practices and make ethical decisions

Creativity

Creativity in automotive technology involves exploring and playing with ideas and concepts in order to represent thinking, solve problems, explore opportunities, and innovate in unique ways. It is the interaction between intuition and thinking.

When creativity as a competency is applied in automotive technology, learners

- demonstrate initiative, open-mindedness, inventiveness, flexibility, and a willingness to **take prudent risks** in thinking about various processes and while recognizing safety protocols
- demonstrate **curiosity** by exploring new ideas, possibilities, and emerging trends, as well as by **asking relevant questions**
- **use safe strategies** and procedures to make adaptations and adjustments when solving problems or generating innovative ideas
- enhance innovative ideas **by building on** prior knowledge and **the ideas of others**
- **create a plan** for a procedure or process and **adjust** it as needed to achieve the goal of successfully meeting a learning outcome
- **test and adapt** procedures or processes to **persevere** through obstacles to improve process, efficiency, effectiveness, and customer service
- use **reflective practice** by **welcoming feedback** from others to enhance the process

Citizenship

Citizenship in **automotive technology** involves engaging and working toward a more equitable, compassionate, and sustainable world by developing and valuing relationships to self, others, and the natural world.

When citizenship as a competency is applied in automotive technology, learners

- understand **their own perspective** on issues related to automotive systems and service
- recognize **discrimination, principles of equity, and human rights** in the workplace
- explore the **interconnectedness** of self, the workplace, and the natural world as they make decisions in the workplace and select materials and consumables
- welcome **diverse viewpoints, experiences, and world views,** and appreciate how they contribute to building relationships and practices
- **empathize** with multiple viewpoints to better understand consumers, markets, workplaces, teams, and co-workers
- connect with others in **responsible, respectful, and inclusive ways,** both in person and in digital contexts

- **realize their potential** in contributing to the betterment of both their workplace and the wider community with the decisions they make
- work to support diversity, inclusivity, and human rights by finding **equitable solutions** in the workplace that support well-being for all
- make **ethical choices** to promote healthy and sustainable outcomes

Connection to Self

Connection to self in automotive technology involves awareness of one's identity, the ability to self-regulate, make and reflect on decisions, and the responsibility for personal growth, well-being, and well-becoming.

When connection to self as a competency is applied in automotive technology, learners

- recognize **personal strengths, gifts, and challenges** in automotive systems and service that support their learning and well-being
- come to know the **factors that shape their identity** as automotive technicians, and see themselves as professionals
- use workplace skills and practices to enhance **self-regulation**, personal comfort, sense of well-being, and efficiency
- **reflect** on their own decisions, effort, and experiences, and others' feedback as they improve their skills as automotive technicians
- **set goals** to strengthen their career and personal aspirations as automotive technicians
- create a **personal plan** that reflects their career goals, encompassing strengths and interests
- value and practise resilience as they work through mistakes and **overcome obstacles** in their skills and understanding of automotive technology
- demonstrate the ability **to change or adapt** to new experiences when presented with obstacles or new information
- recognize and **embrace their role** in lifelong learning, well-being, and well-becoming

Collaboration

Collaboration in automotive technology involves learning with and from others and working together with a shared commitment to a common goal.

When collaboration as a competency is applied in automotive technology, learners

- welcome **diverse viewpoints**, experiences, and world views, and appreciate how they contribute to building relationships and practices

- understand that when they **build on each other's ideas** through discussion, sharing practices, ideas, and stories, their understanding is deepened
- **value** and **put trust in others'** contributions when working together to ensure safe practices
- practise **active listening** and formulate **questions** of themselves and others to generate new ideas and deepen understanding
- **work through differences** and show a willingness to **compromise** or change perspective by demonstrating effective conflict-resolution practices/strategies and appropriate workplace etiquette and protocols
- **co-construct** understanding of current practices and emerging technologies
- **commit** to their roles to maintain a safe work environment, to communicate effectively, and to engage in group procedures

Communication

Communication in automotive technology involves interacting with others and allowing for a message to be received, expressed, and understood in multiple ways and for a variety of purposes.

When communication as a competency is applied in automotive technology, learners

- express ideas while using workplace **cues, conventions**, and professionalism, and while being aware of both word choice and body language
- understand context, adapting to different **audiences and purposes** and conveying information clearly and concisely
- understand how their **words and actions** shape their identity or have an impact on their relationships with colleagues and customers
- are aware of workplace **cues, practices, and protocols,** such as word choice and body language, and use them to understand and interpret messages
- **seek to understand** others' ideas and instructions through use observation, active listening, and questioning as they seek to understand and interpret their peers and customers
- recognize that diverse **contexts** (of language, culture, age, etc.) **can impact and influence understanding**
- make meaning and deepen understanding **through their own language and the languages** of clients and colleagues
- **build relationships** through meaningful interactions using inclusive and respectful language, and correct terminology, both in person and in digital contexts
- recognize the benefits of communication to **build community** in their workplace and broader world

Enduring Understandings

Explore career opportunities.

Technical-vocational education supports learners to understand the unique characteristics, scope, working conditions, and career opportunities of various occupations to make informed choices.

Create safe, healthy, and effective workspaces.

Technical-vocational education provides learners with safe and healthy, effective work practices and protocols that meet industry standards for technical competence and professionalism.

Navigate the world.

Technical-vocational education prepares learners with attitudes, skills, and knowledge to successfully navigate complex, competitive, and collaborative environments to develop an awareness of regulations, cultural competence, and ethical practices.

Experience connected and innovative learning.

Technical-vocational education readies learners to be entrepreneurial and innovative thinkers while making cross-curricular connections and transdisciplinary experiences (STEAM), utilizing industry-standard digital tools and technologies and fostering awareness of industry trends.

Promote inclusive and responsive systems.

Technical-vocational education promotes equity, diversity, and inclusion; is responsive to global challenges; and promotes environmental stewardship to prepare learners for an interconnected world.

Prepare for evolving economies.

Technical-vocational education equips learners with relevant and adaptable skills to become lifelong learners in an ever-changing world.

Learning Outcomes

With teacher guidance and emerging independence, learners can achieve the following learning outcomes.

Strand A: Trade Safety (A2)

AUT-12B-A2 Recognize, explain, and demonstrate personal protective equipment (PPE) requirements and standards in the workplace.

AUT-12B-A2-1 Recognize various **personal protective equipment** (PPE), including

- eye protection
- face protection
- hearing protection
- foot protection
- head protection
- hand protection
- skin protection
- respiratory protection
- protective clothing
- fall protection (trade-specific)

AUT-12B-A2-2 Explain various **personal protective equipment** (PPE), including

- selection of the appropriate PPE
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance

AUT-12B-A2-3 Demonstrate how to use the required **personal protective equipment** (PPE), ensuring

- a proper fit
- a proper seal
- it is worn properly
- an understanding of the procedures for reporting any damage or malfunctions

AUT-12B-A5 Recognize and explain injury prevention.

AUT-12B-A5-1 Recognize, explain, and demonstrate the **SAFE acronym**.

- **S**pot the hazard
- **A**ssess the risk
- **F**ind a safer way
- **E**very day

AUT-12B-A5-12 Demonstrate knowledge of the **locations of various fire emergency safety equipment** and evacuation safety measures, including

- fire extinguisher
- alarm pull stations
- emergency exits
- muster points

AUT-12B-A6 Recognize and explain injury response.

AUT-12B-A6-1 Explain how to **manage a scene** when responding to an injury, such as by

- staying calm
- keeping the area safe
- providing support until trained help arrives

AUT-12B-A6-2 Explain how to **report an injury**, including reporting the injury to

- a teacher or supervisor
- Workers Compensation Board of Manitoba (WCB)

AUT-12B-A6-3 Demonstrate knowledge of the **locations of various emergency safety equipment**, including

- first aid kit
- eyewash station
- automated external defibrillator (AED)

Strand B: Career Education (A1)

AUT-12B-B1 Explain the structure and scope of the automotive service technician trade.

AUT-12B-B1-1 Explain opportunities and future **career paths** in the trade, including

- becoming a specialist
- moving into leadership
- working in different locations

- growing with new technology

AUT-12B-B2 Explain the levels of workplace competency.

AUT-12B-B2-1 Explain **job competencies** workers and learners need to know related to **workplace culture**, including

- understanding tools and materials
- using the right skills to do the job well

AUT-12B-B2-2 Explain the **social competencies** workers and learners need to know related to **workplace culture**, including

- working well with others
- using appropriate language
- respecting different beliefs
- understanding workplace rules
- supporting fairness and inclusion

Strand C: Trade-Related Communications (A4)

AUT-12B-C1 Explain and demonstrate techniques for effective verbal and non-verbal communication.

AUT-12B-C1-1 Explain how to communicate clearly and respectfully with various people at school and/or work, using both **words and body language**.

AUT-12B-C1-2 Demonstrate how to communicate clearly and respectfully with various people at school and/or work, using both **words and body language**.

AUT-12B-C2 Recognize workplace behaviours and communication that constitute bullying, as defined by the Canadian Human Rights Act and jurisdictional human rights laws.

AUT-12B-C2-1 Recognize what **respectful workplace** values look like and what kinds of behaviour are considered bullying, harassment, or discrimination under Canadian law.

AUT-12B-C3 Demonstrate effective communication skills, and practise active listening and response.

AUT-12B-C3-1 Demonstrate **effective communication and active listening,** including

- listening carefully
- responding clearly
- using appropriate body language
- asking questions
- being open to feedback

AUT-12B-C6 Recognize types of trade-related documents and explain their applications.

AUT-12B-C6-1 Recognize various **documents** used in trade, including

- codes and standards
- company policies
- vehicle identification number (VIN)
- schematics, service information, and manufacturers' specifications
- technical service bulletins (TSB)
- industry standard labour guides

AUT-12B-C6-2 Explain various **documents** used in trade, including

- selection of the appropriate document
- its characteristics and key features
- its application (i.e., role or utility in specific scenarios)
- its limitations in scope

AUT-12B-C7 Explain the procedures used to prepare and/or complete trade-related documents.

AUT-12B-C7-1 Explain the procedures used to prepare and/or complete trade-related documents, such as

- work and repair orders
- pre-delivery inspection
- preventative maintenance
- estimates

AUT-12B-C8 Explain the importance of communicating job requirements.

AUT-12B-C8-1 Explain the importance of clearly defining what a job entails so that each team member understands exactly what is expected of them.

Strand D: Trade-Related Mathematics (A5)

AUT-12B-D1 Use mathematical properties to solve problems involving whole, fractional, decimal, and percentage numbers, with an emphasis on trade-related problems.

AUT-12B-D1-1 Demonstrate how to solve math problems with both **positive and negative numbers**, indicating how the signs (+ or –) affect the answer, when

- adding
- subtracting
- multiplying
- dividing

AUT-12B-D1-2 Recognize various **types of fractions**, including

- proper fractions
- improper fractions
- mixed fractions

AUT-12B-D1-3 Explain various **types of fractions**, including

- a proper fraction has a smaller number on top (like $\frac{3}{4}$)
- an improper fraction has a bigger number on top (like $\frac{5}{3}$)
- a mixed fraction combines a whole number and a fraction (like $1\frac{2}{3}$)

AUT-12B-D1-4 Demonstrate how to add and subtract **fractions**.

AUT-12B-D1-5 Demonstrate how to multiply, divide, simplify (reduce), and expand **fractions.**

AUT-12B-D1-6 Demonstrate how to change a fraction into a **decimal** and a decimal into a fraction.

AUT-12B-D1-7 Demonstrate how to calculate **percentages** in trade situations, such as

- when material costs increase by 10%
- when applying a 15% discount

AUT-12B-D2 Demonstrate how to communicate measurements.

AUT-12B-D2-1 Demonstrate how to **measure.**

AUT-12B-D2-2 Demonstrate how to **measure** using both **metric and customary** (imperial) measurement systems, such as when

- measuring length
- measuring materials

AUT-12B-D2-3 Demonstrate how to provide **measurements,** including how much the measurements can vary (e.g., torque specs).

AUT-12B-D3 Calculate the perimeter, area, and volume of simple and complex shapes, using both metric and customary units of measurement.

AUT-12B-D3-1 Demonstrate how to calculate various **circumferences**, including

- circles
- arc lengths
- sectors
- segments

AUT-12B-D3-2 Demonstrate how to calculate various **areas**, including

- circles
- arc lengths
- sectors
- segments

AUT-12B-D3-3 Demonstrate how to calculate various **volumes**, including

- prisms
- spheres
- cylinders

AUT-12B-D4 Solve problems using ratio and proportion.

AUT-12B-D4-1 Demonstrate how to use **ratios and proportions** to solve problems, including

- direct proportion (as one value increases, the other also increases)
  - If a car uses seven litres of fuel to travel 120 km, how much fuel will it use to travel 250 km?
- indirect (inverse) proportion (as one value increases, the other decreases)
  - If a car takes four hours to travel a certain distance at 60 km/h, how long will it take at 70 km/h?
- example: Pascal's law

Strand E: Tools and Equipment (A3)

AUT-12B-E1 Recognize, explain, and demonstrate an understanding of terminology associated with tools and equipment.

AUT-12B-E1-1 Recognize **key terms** and **names** of various tools and equipment.

AUT-12B-E1-2 Explain the **names** and **purposes** of various tools and equipment.

AUT-12B-E1-3 Demonstrate an understanding of the **names** and **purposes** of various tools and equipment.

AUT-12B-E2 Recognize the various hazards associated with tools and equipment, and explain and demonstrate the related safe work practices.

AUT-12B-E2-1 Recognize various **hazards** of tools and equipment, including

- harmful noise levels
- lacerations caused by sharp tools or materials
- crush injury hazards
- moving parts on machines that can catch and trap hands or garments
- flying debris hazards

AUT-12B-E2-2 Explain **safe work practices** for various tools and equipment, including

- wearing appropriate personal protective equipment (PPE)
- inspecting tools and equipment before use
- using the correct tool for the job
- keeping the work area clean and organized
- following manufacturer instructions and safety guidelines
- disconnecting power tools when not in use or during maintenance
- reporting and removing damaged tools from service
- staying alert and avoiding distractions while working
- using guards and safety devices as intended
- storing tools properly after use

AUT-12B-E2-3 Demonstrate **safe work practices** related to tools and equipment.

Strand F: Materials and Consumables

AUT-12B-F1 Share and discuss Indigenous perspectives and environmental impacts.

AUT-12B-F1-1 Share and discuss an **Indigenous perspective** on material selection, emphasizing sustainability, respect for natural resources, and cultural significance, such as

- principles of the honourable harvest
- four sacred elements (earth, wind, water, fire)
- inviting an Elder to teach sustainability

AUT-12B-F1-2 Share and discuss the **environmental impact** of selecting and disposing of various materials.

AUT-12B-F2 Recognize the various hazards associated with consumables and materials, and explain and demonstrate the related safe work practices.

AUT-12B-F2-1 Recognize various **hazards** of consumables and materials, including

- harmful noise levels
- lacerations caused by sharp tools or materials
- crush injury hazards
- moving parts on machines that can catch and trap hands or garments
- flying debris hazards

AUT-12B-F2-2 Describe **safe work practices** for various consumables and materials, including

- wearing appropriate personal protective equipment (PPE)
- inspecting consumables and materials before use
- using the correct consumables and materials for the job
- keeping the work area clean and organized
- following manufacturer instructions and safety guidelines
- reporting and removing damaged consumables and materials from service
- staying alert and avoiding distractions while working
- storing consumables and materials properly after use

AUT-12B-F2-3 Demonstrate safe work practices related to **consumables and materials**.

AUT-12B-F3 Recognize and explain organizing materials, including their characteristics, applications, and procedures.

AUT-12B-F3-1 Recognize various **materials and consumables**.

AUT-12B-F3-2 Explain various **materials and consumables**, including

- selection of the appropriate materials or consumables
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-F3-3 Demonstrate how to safely and properly use various types of **materials and consumables**.

Strand G: Driveline Systems (A6)

AUT-12B-G1 Recognize, explain, and demonstrate an understanding of terminology associated with driveshafts and axles.

AUT-12B-G1-1 Recognize **key terms** and **names** of various driveshafts and axles.

AUT-12B-G1-2 Explain the **names** and **purposes** of various driveshafts and axles.

AUT-12B-G1-3 Demonstrate an understanding of the **names** and **purposes** of various driveshafts and axles.

AUT-12B-G2 Recognize the various hazards associated with driveshafts and axles, and explain and demonstrate the related safe work practices.

AUT-12B-G2-1 Recognize various driveshaft and axle **hazards,** and explain the **safe work practices** for each of the following:

- personal (e.g., use proper lifting techniques and wear PPE)
- facility (e.g., ensure the vehicle is securely lifted)
- vehicle (e.g., follow manufacturer guidelines)
- environmental (e.g., dispose of old parts and fluids properly)

AUT-12B-G2-2 Demonstrate **safe work practices** related to driveshaft and axle systems.

AUT-12B-G3 Recognize tools and equipment relating to driveshafts and axles, and explain their applications and procedures for use.

AUT-12B-G3-1 Recognize various **tools and equipment** used for driveshafts and axles, including

- dial indicator
- inclinometer
- vibration analyzer

AUT-12B-G3-2 Explain various **tools and equipment** used for driveshafts and axles, including

- selection of the appropriate tool
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-G3-3 Demonstrate how to safely and properly use various **tools and equipment** for driveshaft and axle systems.

AUT-12B-G4 Recognize types of driveshafts and their components, and explain their purpose and operation.

AUT-12B-G4-1 Recognize various types of **driveshafts**, including

- front-wheel drive (CV shafts)
- rear-wheel drive

AUT-12B-G4-2 Explain various types of **driveshafts**, including

- selection of the appropriate driveshaft
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-G4-3 Recognize various driveshaft **components**, including

- slip yokes and flanges
- flex joints
- single cardan joints
- double cardan joints
- support bearing
- viscous coupling

AUT-12B-G4-4 Explain various driveshaft **components**, including

- selection of the appropriate driveshaft component
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance

- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-G4-5 Demonstrate how to safely and properly use procedures for **repairing or replacing** various driveshaft systems.

AUT-12B-G5 Recognize types of axles, and explain their components and operation.

AUT-12B-G5-1 Recognize various **axles**, including

- half shafts (independent suspension)
- floating
- semi-floating

AUT-12B-G5-2 Explain various **axles**, including

- selection of the appropriate axles
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-G5-3 Recognize various axle **components**, including

- axle shaft
- differential
- axle housing
- wheel hub
- bearings
- CV joints
- u-joints
- seals
- gaskets
- brake components
- axle flange

AUT-12B-G5-4 Explain various axle **components**, including

- selection of the appropriate axle components
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance

- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-G5-5 Demonstrate how to safely and properly use procedures for **repairing or replacing** various axle systems.

AUT-12B-G6 Recognize types of lubricants, fasteners, gaskets, seals, and sealants, and explain their applications in relation to driveshafts and axles.

AUT-12B-G6-1 Recognize various axle **lubricants, fasteners, gaskets, seals, and sealants**, such as

- lubricants: gear oil, grease
- fasteners: bolts, studs, snap rings
- gaskets: cover, flange
- seals: oil, dust, o-rings
- sealants: RTV, threadlocker

AUT-12B-G6-2 Explain various axle **lubricants, fasteners, gaskets, seals, and sealants**, including

- selection of the appropriate lubricants, fasteners, gaskets, seals, and sealants
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-G6-3 Demonstrate how to safely and properly use procedures for various **lubricants, fasteners, gaskets, seals, and sealants**.

Strand H: Engine Fundamentals (A7)

AUT-12B-H1 Recognize, define, and demonstrate an understanding of terminology associated with engine fundamentals.

AUT-12B-H1-1 Recognize **key terms** and **names** of various engine fundamentals.

AUT-12B-H1-2 Explain the **names** and **purposes** of various engine fundamentals.

AUT-12B-H1-3 Demonstrate an understanding of the **names** and **purposes** of various engine fundamentals.

AUT-12B-H2 Recognize the various hazards associated with engine systems, and explain and demonstrate the related safe work practices.

AUT-12B-H2-1 Recognize various engine system **hazards** and explain the **safe work practices** for each of the following:

- personal (e.g., use proper lifting techniques and wear PPE)
- facility (e.g., ensure the vehicle is securely lifted)
- vehicle (e.g., follow manufacturer guidelines)
- environmental (e.g., dispose of old parts and fluids properly)

AUT-12B-H2-2 Demonstrate **safe work practices** related to engine systems.

AUT-12B-H3 Recognize tools and equipment related to engine fundamentals, and explain their applications and procedures for use.

AUT-12B-H3-1 Recognize various **tools and equipment** used for engine fundamentals.

AUT-12B-H3-2 Explain various **tools and equipment** used for engine fundamentals, including

- selection of the appropriate tools or equipment
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-H3-3 Demonstrate how to safely and properly use various **tools and equipment** for engine fundamentals.

AUT-12B-H6 Explain internal combustion principles.

AUT-12B-H6-1 Explain various principles of **internal combustion** for different engines, including

- two-stroke
- four-stroke
- rotary

AUT-12B-H7 Recognize and explain types of engine classifications, configurations, and their construction.

AUT-12B-H7-1 Recognize the various types of **classification** and construction of different engines, including

- diesel
- gasoline
- alternate fuels

AUT-12B-H7-2 Explain the various types of **classification** and construction of different engines, including

- selection of the appropriate engine
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-H7-3 Recognize the various types of **configuration** and construction of different engines, including

- inline
- rotary
- opposed
- v-type
- w-type

AUT-12B-H7-4 Explain the various types of **configuration** and construction of different engines, including

- selection of the appropriate configuration and construction
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-H8 Recognize and explain types of valvetrain configurations and their construction.

AUT-12B-H8-1 Recognize the various configurations and construction of different **valvetrains**, including

- push rod
- overhead cam
- multi-valve
- solenoid-operated valve

AUT-12B-H8-2 Explain the various configurations and construction of different **valvetrains**, including

- selection of the appropriate valvetrain configuration
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-H9 Recognize engine components, and explain their design, purpose, and operation.

AUT-12B-H9-1 Recognize various engine **components**, including

- block assembly
- cylinder head assembly
- timing gear
- timing belt
- timing chain
- variable valve timing

AUT-12B-H9-2 Explain various engine **components**, including

- selection of the appropriate engine component
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-H9-3 Demonstrate how to safely and properly use procedures for **repairing or replacing** various engine components.

AUT-12B-H10 Recognize types of fasteners, gaskets, seals, and sealants, and explain their applications and procedures in relation to engine fundamentals.

AUT-12B-H10-1 Recognize various engine **fasteners, gaskets, seals, and sealants**, such as

- fasteners: head bolts, main bearing bolt
- gaskets: head gasket, oil pan gasket
- seals: crankshaft seal, valve stem seal
- sealants: RTV silicone, thread sealant

AUT-12B-H10-2 Explain various engine **fasteners, gaskets, seals, and sealants**, including

- selection of the appropriate fasteners, gaskets, seals, and sealants
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-H10-3 Demonstrate how to safely and properly use procedures for **repairing or replacing** various fasteners, gaskets, seals, and sealants.

AUT-12B-H11 Calculate engine displacement, compression ratios, horsepower, area, and volume.

AUT-12B-H11-1 Demonstrate the calculations of various engine parameters, including

- engine displacement
- compression ratio
- horsepower
- area
- volume

AUT-12B-H12 Demonstrate how to safely and properly use procedures for repairing various engine systems.

AUT-12B-H12-1 Demonstrate how to safely and properly use procedures for **repairing** various engine systems.

Strand K: Steering and Suspension (A10)

AUT-12B-K1 Recognize, explain, and demonstrate an understanding of terminology associated with steering and suspension systems.

AUT-12B-K1-1	Recognize **key terms** and **names** of various steering and suspension systems.
AUT-12B-K1-2	Explain the **names** and **purposes** of various steering and suspension systems.
AUT-12B-K1-3	Demonstrate an understanding of the **names** and **purposes** of various steering and suspension systems.

AUT-12B-K2 Recognize the various hazards associated with steering and suspension systems, and explain and demonstrate the related safe work practices.

AUT-12B-K2-1	Recognize steering and suspension **hazards** and explain **safe work practices** for each of the following: • personal (e.g., crush injuries from coil springs) • facility (e.g., leaking shocks or steering system) • vehicle (e.g., follow manufacturer guidelines) • environmental (e.g., dispose of old parts and fluids properly)
AUT-12B-K2-2	Demonstrate **safe work practices** related to steering and suspension systems.

AUT-12B-K3 Recognize tools and equipment related to steering and suspension systems, and explain their applications and procedures for use.

AUT-12B-K3-1	Recognize various **tools and equipment** used for steering and suspension systems.
AUT-12B-K3-2	Explain various **tools and equipment** used for steering and suspension systems, including • selection of the appropriate tool • characteristics and key features • application (i.e., role or utility in specific scenarios) • limitations in scope or performance • procedures for conducting a thorough inspection • procedures for regular maintenance • guidelines for proper storage
AUT-12B-K3-3	Demonstrate how to safely and properly use various **tools and equipment** for engine fundamentals.

AUT-12B-K4 Recognize types of frames and body construction.

AUT-12B-K4-1 Recognize various types of **frames and body** construction, including

- unibody construction
- body-on-frame construction

AUT-12B-K4-2 Explain various types of **frames and body** construction, including

- selection of the appropriate frame and body
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance

AUT-12B-K5 Recognize types of steering systems, and explain their components and operation.

AUT-12B-K5-1 Recognize various **steering systems**, including

- electric
- hydraulic
- variable

AUT-12B-K5-2 Explain various **steering systems**, including

- selection of the appropriate steering system
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance

AUT-12B-K5-3 Recognize various **steering systems components**, such as

- linkage
- recirculating ball
- steering wheel
- steering column
- rack and pinion or steering box
- tie rods
- steering knuckle
- power steering pump or electric motor

AUT-12B-K5-4 Explain various **steering systems components**, including

- selection of the appropriate steering system components
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-K5-5 Demonstrate how to safely and properly use procedures for **repairing or replacing** various steering systems.

AUT-12B-K6 Recognize types of suspension systems, and explain their components and operation.

AUT-12B-K6-1 Recognize various **suspension systems**, such as

- MacPherson strut
- double wishbone (A-arm)
- multi-link suspension
- torsion beam
- leaf spring suspension
- air suspension
- coil spring suspension
- hydraulic suspension

AUT-12B-K6-2 Explain various **suspension systems**, including

- selection of the appropriate suspension system
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance

AUT-12B-K6-3 Recognize various **suspension systems components**, including

- coil springs
- leaf springs
- torsion bar springs
- air springs
- struts

- shocks
- independent
- solid axle

AUT-12B-K6-4 Explain various **suspension systems components**, including

- selection of the appropriate suspension system component
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-K6-5 Demonstrate how to safely and properly use procedures for **repairing or replacing** various suspension systems.

AUT-12B-K7 Recognize types of fluids and lubricants, fasteners, tubing, hoses, gaskets, and seals, and explain their applications in relation to steering and suspension systems.

AUT-12B-K7-1 Recognize various steering and suspension system **lubricants, fasteners, gaskets, seals, and sealants**, such as

- lubricants: power steering fluid, grease, hydraulic fluid
- fasteners: bolts, nuts, cotter pins
- tubing: power steering hoses, suspension lines
- gaskets: pump gaskets, reservoir gaskets
- seals: rack seals, strut seals, dust boots

AUT-12B-K7-2 Explain various steering and suspension system **lubricants, fasteners, gaskets, seals, and sealants**, including

- selection of the appropriate lubricants, fasteners, gaskets, seals, and sealants
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-K7-3 Demonstrate how to safely and properly use procedures for various **lubricants, fasteners, gaskets, seals, and sealants**.

Strand L: Braking (A11)

AUT-12B-L1 Recognize, explain, and demonstrate an understanding of terminology associated with braking systems.

AUT-12B-L1-1	Recognize **key terms** and **names** of various braking systems.
AUT-12B-L1-2	Explain the **names** and **purposes** of various braking systems.
AUT-12B-L1-3	Demonstrate an understanding of the **names** and **purposes** of various braking systems.

AUT-12B-L2 Recognize the various hazards associated with braking systems, and explain and demonstrate the related safe work practices.

AUT-12B-L2-1	Recognize braking system **hazards** and explain the **safe work practices** for each of the following: • personal (e.g., hot brakes) • facility (e.g., fluid spills) • vehicle (e.g., improper maintenance) • environmental (e.g., dispose of old parts and fluids properly)
AUT-12B-L2-2	Demonstrate **safe work practices** related to braking systems.

AUT-12B-L3 Recognize tools and equipment related to braking systems, and explain their applications and procedures for use.

AUT-12B-L3-1	Recognize various **tools and equipment** used for braking systems.
AUT-12B-L3-2	Explain various **tools and equipment** used for braking systems, including • selection of the appropriate tool • characteristics and key features • application (i.e., role or utility in specific scenarios) • limitations in scope or performance • procedures for conducting a thorough inspection • procedures for regular maintenance • guidelines for proper storage
AUT-12B-L3-3	Demonstrate how to safely and properly use various **tools and equipment** for braking systems.

AUT-12B-L4 Explain principles related to braking systems.

AUT-12B-L4-1 Explain braking systems **principles**, including

- Pascal's law
- coefficients of friction
- kinetic energy

AUT-12B-L5 Recognize types of braking systems, and explain their components and operation.

AUT-12B-L5-1 Recognize various **braking systems**, including

- disc
- drum
- parking

AUT-12B-L5-2 Explain various **braking systems**, including

- selection of the appropriate braking system
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance

AUT-12B-L5-3 Recognize various braking system **components**, such as

- brake pedal
- master cylinder
- brake lines
- calipers
- brake pads
- rotors
- drums
- brake shoes

AUT-12B-L5-4 Explain various braking system **components**, including

- selection of the appropriate braking system component
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-L5-5 Recognize various **power assists**, including

- vacuum
- hydraulic
- electric

AUT-12B-L5-6 Explain various **power assists**, including

- selection of the appropriate power assist
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance

AUT-12B-L5-7 Recognize various **power assist components**, including

- brake booster
- power steering pump
- electric power steering motor
- hydraulic control unit (HCU)
- vacuum pump
- electric vacuum pump
- hydro-boost unit
- electronic brake control module (EBCM)
- steering angle sensor
- active suspension compressor

AUT-12B-L5-8 Explain various **power assist components**, including

- selection of the appropriate power assist component
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-L5-9 Demonstrate how to safely and properly use procedures for **repairing or replacing** various braking systems.

AUT-12B-L6 Recognize types of fluids, fittings, flaring, tubing, and hoses, and explain their applications and procedures for use related to braking systems.

AUT-12B-L6-1 Recognize various braking system **fluids, fittings, flaring, tubing, and hoses,** such as

- fluids: brake fluid
- fittings: banjo bolt, inverted flare
- flares: double flare, ISO bubble flare
- tubing: steel brake lines, copper-nickel tubing
- hoses: rubber brake, braided stainless steel

AUT-12B-L6-2 Explain various braking system **fluids, fittings, flaring, tubing, and hoses,** including

- selection of the appropriate fluids, fittings, flaring, tubing, and hoses
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-L6-3 Demonstrate how to safely and properly use procedures for **repairing or replacing fluids, fittings, flaring, tubing, and hoses.**

Strand N: Body Components, Accessories, and Trim (A13)

AUT-12B-N1 Identify, describe, and demonstrate an understanding of terminology associated with body components, accessories, and trim.

AUT-12B-N1-1 Identify **key terms** and **names** of various body components, accessories, and types of trim.

AUT-12B-N1-2 Describe the **names** and **purposes** of various body components, accessories, and types of trim.

AUT-12B-N1-3 Demonstrate an understanding of the **names** and **purposes** of various body components, accessories, and types of trim.

AUT-12B-N2 Identify the various hazards associated with body components, accessories, and trim, and describe and demonstrate the related safe work practices.

AUT-12B-N2-1 Identify body components, accessories, and trim **hazards,** and describe the **safe work practices** for each of the following:

- personal (e.g., eye injury from clips snapping loose)

- facility (e.g., ventilation for paints or solvents)
- vehicle (e.g., follow manufacturer guidelines)
- environmental (e.g., dispose of old parts and fluids properly)

AUT-12B-N2-2 Demonstrate **safe work practices** related to body components, accessories, and trim.

AUT-12B-N3 Identify and describe tools and equipment related to body components, accessories, and trim, and demonstrate their applications and procedures for use.

AUT-12B-N3-1 Identify various **tools and equipment** used for body components, accessories, and trim.

AUT-12B-N3-2 Describe various **tools and equipment** used for body components, accessories, and trim, including

- selection of the appropriate tool
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-N3-3 Demonstrate how to safely and properly use various **tools and equipment** for body components, accessories, and trim.

AUT-12B-N4 Identify various body components, accessories, and types of trim, and describe their applications and procedures for use.

AUT-12B-N4-1 Identify various interior and exterior body components, including

- locks
- latches
- windows

AUT-12B-N4-2 Describe various interior and exterior body components, including

- selection of the appropriate body components
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-N4-3 Identify various interior and exterior body accessories.

AUT-12B-N4-4 Describe various interior and exterior body accessories, including

- selection of the appropriate body accessories
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-N4-5 Identify various interior and exterior types of body trim.

AUT-12B-N4-6 Describe various interior and exterior types of body trim, including

- selection of the appropriate body trim
- characteristics and key features
- application (i.e., role or utility in specific scenarios)
- limitations in scope or performance
- procedures for conducting a thorough inspection
- procedures for regular maintenance
- guidelines for proper storage

AUT-12B-N4-7 Demonstrate how to safely and properly use procedures for **repairing or replacing** interior and exterior body components, accessories, and trim.

Curriculum Implementation Resources

Curriculum implementation resources are frequently added. You are encouraged to visit the website regularly.