Grade 12C Advanced Electrical Systems

Course Code	8702
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 electrical and electronic systems, building on the knowledge gained in the fundamental courses. They will focus on the detailed function and interaction of electrical and electronic 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 electrical and electronic systems and components. Learners will also apply advanced mathematical concepts relevant to the automotive trade.

Manitoba

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

- A8 Electrical Systems and Components
- A9 Starting and Charging Systems, and Low Voltage Batteries I
- A14 Hybrid and Electric Vehicle Systems I

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 independence and an emerging ability to guide others, learners can achieve the following learning outcomes.

Strand A: Trade Safety (A2)

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

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

AUT-12C-A5-1 Identify, explain, and demonstrate the **SAFE acronym**.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

AUT-12C-C6-1 Recognize various **documents** used in the 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-12C-C6-2 Explain various **documents** used in the 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-12C-C7 Explain the procedures used to prepare and/or complete trade-related documents.

AUT-12C-C7-1 Explain the procedures used to prepare and/or complete trade-related documents.

- work and repair orders
- pre-delivery inspection

- preventative maintenance
- estimates

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

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

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

- proper fractions
- improper fractions
- mixed fractions

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

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

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

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

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

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

AUT-12C-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 110 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?
- Use of Ohm's and Watt's laws

Strand E: Tools and Equipment (A3)

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

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

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

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

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

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

Strand F: Materials and Consumables

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

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

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

AUT-12C-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-12C-F2-2 Explain **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-12C-F2-3 Demonstrate **safe work practices** related to consumables and materials.

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

AUT-12C-F3-1 Recognize various **materials and consumables**, including

- adhesives
- cleaners
- fasteners
- fittings
- flaring
- fluids
- gaskets
- hoses
- lubricants
- seals
- sealants
- tubing

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

Strand I: Electrical Systems (A8)

AUT-12C-I1 Recognize, explain, and demonstrate an understanding of terminology associated with wiring, electrical, and electronic systems and principles.

AUT-12C-I1-1	Recognize **key terms** and **names** of various wiring, electrical, and electronic systems and principles.
AUT-12C-I1-2	Explain the **names** and **purposes** of various wiring, electrical, and electronic systems and principles.
AUT-12C-I1-3	Demonstrate an understanding of the **names** and **purposes** of various wiring, electrical, and electronic systems and principles.

AUT-12C-I2 Identify the various hazards associated with wiring, electrical, and electronic systems, and describe and demonstrate the related safe work practices.

AUT-12C-I2-1	Recognize various electrical and electronic **hazards,** and explain the **safe work practices** for each of the following: • personal (e.g., burns from over-heated components) • facility (e.g., tripping from wire and cable) • vehicle (e.g., follow manufacturer guidelines) • environmental (e.g., dispose of old parts and e-waste)
AUT-12C-I2-2	Demonstrate **safe work practices** related to electrical and electronic systems.

AUT-12C-I3 Recognize tools and equipment related to electrical and electronic systems, and explain their applications and procedures for use.

AUT-12C-I3-1	Recognize various **tools and equipment** used for electrical and electronic systems.
AUT-12C-I3-2	Explain various **tools and equipment** used for electrical and electronic systems, including • selection of the appropriate tool 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-12C-I3-3	Demonstrate how to safely and properly use various **tools and equipment** for electrical and electronic systems.

AUT-12C-I4 Interpret information pertaining to wiring, electrical, and electronic components found on drawings and specifications.

AUT-12C-I4-1	Recognize **diagnostic flowcharts** pertaining to wiring, electrical, and electronics components and systems.
AUT-12C-I4-2	Explain **diagnostic flowcharts** pertaining to wiring, electrical, and electronics components and systems.
AUT-12C-I4-3	Demonstrate how to interpret **diagnostic flowcharts** for wiring, electrical, and electronic components and systems, including • recognizing the specific components and circuits involved • analyzing the flowchart to determine the sequence of diagnostic steps • performing tests and inspections as indicated in the flowchart • using appropriate diagnostic tools • interpreting the results to diagnose and repairing faults in the system
AUT-12C-I4-3	Recognize **schematics** for wiring, electrical, and electronic components and systems.
AUT-12C-I4-4	Explain **schematics** for wiring, electrical, and electronic components and systems.
AUT-12C-I4-5	Demonstrate an understanding of a **schematic** for wiring, electrical, and electronic components and systems, including • recognizing the symbols • analyzing the connections between components • tracing the paths of electrical current • using the schematic to troubleshoot and diagnose

AUT-12C-I5 Recognize and explain basic electrical theory and its applications to electrical circuits.

AUT-12C-I5-1	Recognize the following **electrical theories,** including • conventional theory • electron theory • Ohm's law • Kirchoff's law • Watt's law • series circuit • parallel circuit • series-parallel circuits

AUT-12C-I5-2 Explain the following **electrical theories** and their applications to electrical circuits, including

- conventional theory
- electron theory
- Ohm's law
- Kirchoff's law
- Watt's law
- series circuit
- parallel circuit
- series-parallel circuits

AUT-12C-I5-3 Demonstrate how to apply the following **electrical theories** to electrical circuits:

- conventional theory
- electron theory
- Ohm's law
- Kirchoff's law
- Watt's law
- series circuit
- parallel circuit
- series-parallel circuits

AUT-12C-I6 Recognize types of tools and equipment used to test wiring, electrical, and electronic systems and their components, and demonstrate their use.

AUT-12C-I6-1 Recognize various types of **tools and equipment** used to test wiring, electrical, and electronic systems and their components.

AUT-12C-I6-2 Explain various types of **tools and equipment** used to test wiring, electrical, and electronic systems and their components, 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-12C-I6-3 Demonstrate how to safely and properly use various types of **tools and equipment** to test wiring, electrical, and electronic systems and their components.

AUT-12C-I7 Recognize, explain, and demonstrate the use of tools and equipment related to wire and cables.

AUT-12C-I7-1	Recognize various **tools and equipment** related to wire and cables**.**
AUT-12C-I7-2	Explain various **tools and equipment** related to wire and cables, 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-12C-I7-3	Demonstrate how to safely and properly use various **tools and equipment** related to wire and cables.

AUT-12C-I8 Recognize wire and cables, and explain their characteristics.

AUT-12C-I8-1	Recognize various types of **wires**, including type and size.
AUT-12C-I8-2	Explain various types of **wires**, including • selection of the appropriate wire or cable • 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-12C-I8-3	Identify various types of **cable**, including type and size.
AUT-12C-I8-4	Describe various types of **cable,** including • selection of the appropriate type of cable • 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-12C-I8-5	Demonstrate how to safely and properly replace various **electrical wires or cables.**

AUT-12C-I9 Recognize and explain types of electrical components and their purpose and operation.

AUT-12C-I9-1 Recognize various types of **electrical components**, including

- circuit protection
- control device
- load device

AUT-12C-I9-2 Explain various types of **electrical components**, including

- selection of the appropriate electrical 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-12C-I9-3 Demonstrate how to safely and properly repair or replace various **electrical components.**

AUT-12C-I10 Recognize, explain, and demonstrate the procedures to repair wiring, electrical, and electronic systems.

AUT-12C-I10-1 Recognize various **wire and cable repairs**.

AUT-12C-I10-2 Explain various **wire and cable repairs**, including

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

AUT-12C-I10-3 Demonstrate how to safely and properly complete various **wire and cable repairs**, including

- splicing
- terminal replacement
- soldering
- crimping

AUT-12C-I11 Recognize, explain, and demonstrate the procedures to safely and properly test and diagnose electrical and electronic systems.

AUT-12C-I11-1 Recognize various procedures to **test and diagnose** electrical and electronic systems, including

- resistance measurements
- current measurements
- voltage measurements
- voltage drops

AUT-12C-I11-2 Explain various procedures to **test and diagnose** electrical and electronic systems, including

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

AUT-12C-I11-3 Demonstrate how to safely and properly **test and diagnose** various electrical and electronic systems, including

- resistance measurements
- current measurements
- voltage measurements
- voltage drops

Strand J: Starting and Charging Systems, and Low Voltage Batteries (A9)

AUT-12C-J1 Recognize, explain, and demonstrate an understanding of terminology associated with starting and charging systems, and low voltage batteries.

AUT-12C-J1-1 Recognize **key terms** and **names** of various starting and charging systems, and low voltage batteries.

AUT-12C-J1-2 Explain the **names** and **purposes** of various starting and charging systems, and low voltage batteries.

AUT-12C-J1-3 Demonstrate an understanding of the **names** and **purposes** of various starting and charging systems, and low voltage batteries.

AUT-12C-J2 Identify the various hazards associated with starting and charging systems, and low voltage batteries, and describe and demonstrate the related safe work practices.

AUT-12C-J2-1 Recognize various starting and charging systems, and low voltage systems **hazards**, and explain the **safe work practices** for each of the following:

- personal (e.g., shock from exposed terminals)
- facility (e.g., corrosive damage from battery acid spills)
- vehicle (e.g., follow manufacturer guidelines)
- environmental (e.g., dispose of old parts and fluids properly)

AUT-12C-J2-2 Demonstrate **safe work practices** related to starting and charging systems, and low voltage battery systems.

AUT-12C-J3 Recognize, explain, and demonstrate the use of various types of tools and equipment relating to starting and charging systems, and low voltage (12-volt) batteries.

AUT-12C-J3-1 Recognize various **testing tools and equipment** used to test starting and charging systems, and low voltage (12-volt) battery systems, including

- starting system
- charging system
- low voltage battery

AUT-12C-J3-2 Explain various **testing tools and equipment** used to test starting and charging systems, and low voltage (12-volt) battery 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-12C-J3-3 Demonstrate how to safely and properly use various **testing tools and equipment** for starting and charging systems, and low voltage (12-volt) battery systems.

AUT-12C-J4 Recognize and explain types of starting and charging systems and their components and operation.

AUT-12C-J4-1 Recognize various types of **starting systems**.

AUT-12C-J4-2 Explain various types of **starting systems**, including

- selection of the appropriate starting and charging 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
- guidelines for proper storage

AUT-12C-J4-3 Recognize various types of **charging systems**.

AUT-12C-J4-4 Explain various types of **charging systems**, including

- selection of the appropriate starting and charging 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
- guidelines for proper storage

AUT-12C-J4-5 Recognize various types of starting and charging systems **components**.

AUT-12C-J4-6 Explain various types of starting and charging systems **components**, including

- selection of the appropriate starting and charging systems 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-12C-J4-7 Recognize various types of starting and charging systems **operations**.

AUT-12C-J4-8 Explain various types of starting and charging systems **operations**, including

- selection of the appropriate starting and charging systems operations
- 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-12C-J4-9 Demonstrate how to safely and properly use procedures for **repairing or replacing** various **starting systems.**

AUT-12C-J4-10 Demonstrate how to safely and properly use procedures for **repairing or replacing** various **charging systems.**

AUT-12C-J5 Recognize and explain low voltage (12-volt) batteries and their characteristics.

AUT-12C-J5-1 Recognize various low voltage (12-volt) batteries.

AUT-12C-J5-2 Explain various low voltage (12-volt) batteries, including

- selection of the appropriate low voltage battery
- 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-12C-J5-3 Demonstrate how to safely and properly use procedures for **repairing or replacing** various low voltage (12-volt) battery systems.

Strand O: Hybrid and Electric Vehicle Systems (A14)

AUT-12C-O1 Identify, describe, and demonstrate an understanding of terminology associated with hybrid and electric vehicle (EV) systems.

AUT-12C-O1-1 Identify **key terms** and **names** of various hybrid and electric vehicle (EV) systems.

AUT-12C-O1-2 Describe the **names** and **purposes** of various hybrid and electric vehicle (EV) systems.

AUT-12C-O1-3 Demonstrate an understanding of the **names** and **purposes** of various hybrid and electric vehicle (EV) systems.

AUT-12C-O2 Identify the various hazards associated with hybrid and electric vehicle (EV) systems, and describe the related safe work practices.

AUT-12C-O2-1 Identify **hazards** in hybrid and electric vehicle (EV) systems, and describe **safe work practices** for each of the following:

- personal
  - personal protective equipment (PPE)
  - electrocution hazards
  - one hand rule
- shop/facility
- vehicle
  - properly tagging out the vehicle
  - hybrid vehicle and electric vehicle (EV) identification markers
  - safety precautions for working on high voltage batteries
  - various disconnect procedures
  - verification of voltage
- environmental
- hazards
  - fire
  - shocks
  - arc flash
  - sparks
  - high temperature
  - heavy components
  - sharp edges

AUT-12C-O3 Identify tools and equipment related to hybrid and electric vehicle (EV) safety, and describe their applications and procedures for use.

AUT-12C-O3-1 Identify various safety **tools and equipment** for hybrid and electric vehicles (EVs), including

- personal protective equipment (PPE)
  - high voltage gloves
  - testing high voltage gloves
  - safety glasses
  - insulated steel-toed boots
- high voltage multimeters and leads (Cat III)
- warning pylons
- insulated tools

- platform lift for battery removal
- hook or gaff for electrocution

AUT-12C-O3-2 Describe various safety **tools and equipment** for hybrid and electric vehicles (EVs), including

- selection of the appropriate tools
- 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-12C-O4 Identify and describe the fundamentals of hybrid vehicle and electric vehicle (EV) technology.

AUT-12C-O4-1 Identify various types of **hybrid** vehicle **powertrain** designs, including

- series
- parallel
- series-parallel

AUT-12C-O4-2 Describe various types of **hybrid** vehicle **powertrain** designs, including

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

AUT-12C-O4-3 Identify various **levels of hybrid** vehicles, including

- mild hybrid
- medium hybrid
- full hybrid

AUT-12C-O4-4 Describe various **levels of hybrid** vehicles, including

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

AUT-12C-O4-5 Identify various types of **electric vehicle (EV) powertrain** designs, such as

- BEV: battery electric vehicle
- PHEV: plug-in hybrid electric vehicle
- HEV: hybrid electric vehicle
- FCEV: fuel cell electric vehicle
- EREV: extended-range electric vehicle
- in-wheel motor EV: motor in each wheel

AUT-12C-O4-6 Describe various types of **electric vehicle (EV) powertrain** designs, including

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

AUT-12C-O4-7 Identify the various types of hybrid vehicle and electric vehicle (EV) **high voltage batteries**, including

- lead-acid batteries in series
- nickel-metal hydride
- lithium-ion
- other emerging technologies

AUT-12C-O4-8 Describe the various types of hybrid vehicle and electric vehicle (EV) **high voltage batteries**, including

- selection of the appropriate high voltage battery
- 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

Curriculum Implementation Resources

Curriculum implementation resources are frequently added. Please refer to https://edu.gov.mb.ca/k12/framework/sytep/automotive/resources/index.html.