2019 Saskatchewan Curriculum

Robotics and Automation 10, 20, 30

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Introduction

Practical and Applied Arts in an area of study in Saskatchewan's Core Curriculum which is intended to provide all Saskatchewan students with an education that will serve them well regardless of their choices after leaving school. Through its various components and initiatives, Core Curriculum supports the achievement of the Goals of Education for Saskatchewan. For current information regarding Core Curriculum, please refer to the *Registrar's Handbook for School Administrators* found on the Government of Saskatchewan website. For additional information related to the various components and initiatives of Core Curriculum, please refer to the Government of Saskatchewan website for policy and foundation documents.

This curriculum provides the intended learning outcomes organized in modules from which teachers/schools select a minimum of 100 hours for each course. The curriculum reflects current Practical and Applied Arts education research and updated technology and is responsive to changing demographics within the province.

All students will work toward the achievement of the provincial outcomes. Some students, however, will require additional supports. Effective instruction, including the use of the Adaptive Dimension, will support most students in achieving success. The Adaptive Dimension refers to the concept of making adjustments to any or all of the following variables: learning environment, instruction, assessment and resources. Adjustments to these variables are intended to make learning meaningful and appropriate and to support achievement. **Within the context of the Adaptive Dimension, curricular outcomes are not changed; adaptive variables are adjusted so that they curricular outcomes can be achieved. Please refer to the Saskatchewan Curriculum website for more information on the Adaptive Dimension.**

Course Synopses

Robotics and Automation 10, 20, 30 focuses on the design, construction, operation and use of autonomous and/or radio-controlled robotic devices, as well as the computer systems necessary for their control, sensory feedback and information processing. Through project based learning, design thinking, and inquiry learning, students will explore the processes and skills needed to design and fabricate physical devices that they will control or automate. Students are able to explore wearable technologies, automation, mobile robotics and animatronics as well as traditional robotic devices. In addition, students will also develop the computational thinking and coding skills necessary to control their robotic or automated devices.

Unique Features of Practical and Applied Arts

Curricula in the Practical and Applied Arts (PAA) have several features unique to this area of study. The reasons for inclusion of these features in PAA curricula are to encourage flexibility in school programming, to support community partnerships that facilitate learning beyond the classroom and to ensure the practical emphasis of the program.

PAA curricula contain all courses in a **single document** whether it is one course or a series of several. This feature allows schools and teachers the flexibility to choose modules supportive of their students' needs as well as utilize available facilities and equipment. The order and number of outcomes in a course can vary between schools as long as the integrity of the discipline and the required 100 hours per course are maintained.

All PAA curricula are designed using **modules**, each with a single outcome for students to achieve. To aid teachers and schools in course planning, each module is designated as Introductory, Intermediate, or Advanced. Modules may also have prerequisite modules. Core modules are compulsory modules that must be covered in pure courses of study for developmental or safety reasons. Some modules may serve as prerequisites for more advanced study. Each module provides a suggested time to aid teachers in planning their courses. Each module may take more or less than the suggested time depending on factors such as background knowledge of the students.

A third unique feature of PAA curricula is the inclusion of an optional **Extended Study** module in each course. The Extended Study module allows teachers to create their own outcome and indicators relevant to the purpose and areas of focus for the subject to meet their students' needs. Using Extended Study modules to accommodate advances in technology and changing practices is one way that teachers can ensure their programs stay current with industry standards.

Work Study modules encourage personalized learning and development of community relationships. Work Study is designed as a work-based learning portion of a course to provide off-campus educational opportunities for individuals or small groups in a work setting. Planning and assessment are managed by the teacher while the learning opportunity is provided by an expert in the community. Practical skills developed in school are directly transferred to a work environment.

Transferable work skills are a desirable aspect of lifelong learning. The practical nature of these skills enriches students' lives as they transition into life beyond Grade 12. In Canada, two taxonomies of transferable work skills have been produced. The Conference Board of Canada developed a list of Employability Skills and Human Resources and Service Development Canada identified a series of Essential Skills. Students will be familiar with both of these taxonomies from their learning in Grade 8 Career Education.

More details on the above curriculum features are provided in the *Practical and Applied Arts Handbook* available on the Ministry of Education website.

Purpose and Areas of Focus for Robotics and Automation

Robotics and Automation deals with the design, construction, operation and use of robotic devices, as well as the computer systems necessary for their control, sensory feedback and information processing. Automation is the technology by which a process or procedure is performed with minimal human assistance.

As such, the purpose of this curriculum is to facilitate innovation, and exploration through the hands-on process of creating and making. Through project based learning, design thinking, and inquiry learning, students will explore the processes and skills needed to design and fabricate physical devices that they will control or automate.

The Areas of Focus for Robotics and Automation are:

- Introductory
- Design Thinking
- Electrical
- Autonomous
- Coding
- Sensors
- Radio Controlled (R/C)
- Machining
- Automation
- Project Management
- Career and Workplace
- Work Study
- Extended Study

Teaching Robotics and Automation

The *Robotics and Automation 10, 20, 30* curriculum is designed to support different approaches to address students' interests. Two suggested course configurations each with Core and suggested Optional modules are provided for each grade; one reflects an autonomous focus and one reflects a radio-controlled focus. An autonomous focus is suitable when the focus is on programming the robotic or autonomous device to perform pre-determined tasks. A radio-controlled focus is suitable when the operation of the device is not pre-determined and needs to be controlled by an operator – such as in many robotics competitions. In either case, students may construct the device completely from scratch or may rely on some level of pre-fabricated parts. Teachers may also choose to adopt a mixed focus that incorporates aspects of autonomous and radio-controlled devices.

The teaching of intelligent automation can be achieved without traditional fabrication and tools; however, tool-based fabrication is essential to the construction of a radio controlled robot. It will depend greatly upon the choice of modules whether this course is taught in a shop environment, a computer lab or a classroom setting.

This curriculum allows students to explore wearable technologies, automation, mobile robotics and animatronics as well as traditional robotic devices. Ubiquitous computing and automation are occurring in tandem. Self-operating machines are permeating every dimension of society, so that humans find themselves interacting more frequently with robotic devices than ever before—often without even realizing it. The human-machine relationship is rapidly evolving as a result. Humanity, and what it means to be a human, will be defined in part by the machines people design.

Computational Thinking – Computational thinking is a broad set of problem-solving processes which represent an entry point for new ways of thinking that are applicable in computer science and non-computer science contexts. Teachers should highlight connections to these aspects of computational thinking while addressing the outcomes in this document. The following are the essential dimensions of computational thinking:

- Decomposition, where a problem is broken into a set of simpler independent sub-problems.
- Pattern recognition, where similarities in related problems are identified.
- Abstraction, where specific differences in problems are viewed more generally, to allow for a single common solution.
- Algorithm design, where a sequence of steps is developed which can be followed to solve a problem.

Elegant Code – Elegant code needs to be simple and easy to understand. Saint-Exupery said, "Perfection is achieved, not when there is nothing more to add, but when there is nothing left to take away." Developing an algorithm which simplifies code often will make it more efficient. Writing elegant code involves carefully analyzing the problem and creating an algorithm with a balance between a minimal amount of code and the code being readable. (from *Computer Science 20, 30*)

Reusable Code – Finding a reusable piece of code and copying and pasting it into a program is a common industry practice. Teaching students how to find the bit of code they want and to interpret how to adapt it is a valuable part of learning to code.

Visual or Block Based Coding – Although it is common to view visual coding environments as easier, students using them have shown greater learning gains and a higher level of interest in future computing courses. Students using purely text based editors viewed their programming experience as more similar to what professional programmers do. However, there is pedagogical value in using both.

Design Thinking – Design thinking is a process for creative problem solving that uses a human-centered approach to innovation. Designers engage in five stages – empathize, design, ideate, prototype and test – in order to focus on what is most important for users. Design thinking is inherent to the project based nature of designing and actualizing a robot or automated device. Students become empowered when they define themselves as makers and inventors and creators by turning questions and ideas into working physical devices that solve particular problems.

Grades 7-12 Practical and Applied Arts

Opportunities available to students within Practical and Applied Arts are numerous. The choices assist students in developing personal skills, gaining entry level employment skills or pursuing apprenticeship opportunities in the trades. Students have the opportunity to explore and develop career pathways.

Each Practical and Applied Arts curriculum is composed of modules configured into courses, along with suggestions for modules that are suitable for middle or secondary level survey courses. PAA curricula are grouped in clusters according to common themes. Because various combinations of modules can be chosen, the courses will have variable occupational or career pathways to post-secondary education and training or workplace opportunities.

The modular design provides for flexibility and for community involvement. The design allows teachers and schools to develop unique PAA offerings that reflect student interest and school/community resources. Partnerships with community businesses and service providers enhance learning opportunities in a community context.

Practical and Applied Arts courses can be offered in two ways within a school—as pure or survey course offerings. A pure course at the secondary level is a course where core (compulsory) modules are taught, and optional modules are selected from the same PAA curriculum to total 100 hours. A survey course is a configuration of modules recommended from a minimum of three pure PAA curricula to create a middle level course of a minimum of 50 hours or a secondary level course to total 100 instructional hours (1 credit). The *Practical and Applied Arts Handbook* offers recommendations for configuring survey courses at the middle and secondary levels.

Broad Areas of Learning

There are three Broad Areas of Learning that reflect Saskatchewan's Goals of Education. All areas of study contribute to student achievement of the Goals of Education through helping students achieve knowledge, skills and attitudes related to these Broad Areas of Learning. The K-12 goals and grade level outcomes for each area of study are designed for students to reach their full potential in each of the following Broad Areas of Learning.

Sense of Self, Community and Place*

(Related to the following Goals of Education: Understanding and Relating to Others, Self Concept Development and Spiritual Development)

Students possess a positive sense of identity and understand how it is shaped through interactions within natural and constructed environments. They are able to nurture meaningful relationships and appreciate diverse beliefs, languages and practices from the diversity of cultures in our province, including First Nations and Métis. Through these relationships, students demonstrate empathy and a

deep understanding of self, others and the influence of place on identity. In striving to balance their intellectual, emotional, physical and spiritual dimensions, students' sense of self, community and place is strengthened.

To engage in the Practical and Applied Arts, students need to use knowledge and skills and to interact with each other. Through the Practical and Applied Arts, students learn about themselves, others, and the world around them. They use their new understanding and skills to explore who they are and who they might become. Practical and Applied Arts programming should vary by school to reflect the community at large. Community projects can play a key role in Practical and Applied Arts programming and connect the school more closely to the community.

Lifelong Learners

(Related to the following Goals of Education: Basic Skills, Lifelong Learning, Positive Lifestyle)

Students are curious, observant and reflective as they imagine, explore and construct knowledge. They demonstrate the understandings, abilities and dispositions necessary to learn from subject discipline studies, cultural experiences and other ways of knowing the world. Such ways of knowing support students' appreciation of Indigenous worldviews and learning about, with and from others. Students are able to engage in inquiry and collaborate in learning experiences that address the needs and interests of self and others. Through this engagement, students demonstrate a passion for lifelong learning.

Students in Practical and Applied Arts courses will gain a positive sense of identity and efficacy through development of practical skills and knowledge. Many Practical and Applied Arts curricula are closely related to careers found in Saskatchewan and, therefore, are directly connected to lifelong learning whether in a professional career or through hobbies and personal interests.

Engaged Citizens

(Related to the following Goals of Education: Career and Consumer Decisions, Membership in Society and Growing with Change)

Students demonstrate confidence, courage and commitment in shaping positive change for the benefit of all. They contribute to the environmental, social and economic sustainability of local and global communities. Their informed life, career and consumer decisions support positive actions that recognize a broader relationship with, and responsibility for, natural and constructed environments. Along with this responsibility, students recognize and respect the mutual benefits of Charter, Treaty and other constitutional rights and relationships. Through this recognition, students advocate for self and others, and act for the common good as engaged citizens.

Engaged citizens have empathy for those around them and contribute to the well-being of the community as a whole. Practical and Applied Arts students learn how new skills and abilities enable them to make a difference in their personal lives as well as in their family and community. Skills and abilities gained in Practical and Applied Arts courses build a sense of confidence which encourages students to participate effectively in their world.

*A sense of place is a geographical concept that attempts to define our human relationships with the environment and knowledge derived from this relationship.

Cross-curricular Competencies

The Cross-curricular Competencies are four interrelated areas containing understanding, values, skills and processes which are considered important for learning in all areas of study. These competencies reflect the Common Essential Learnings and are intended to be addressed in each area of study at each grade.

Developing Thinking

(Related to CEL of Critical and Creative Thinking)

Constructing knowledge (i.e., factual, conceptual, procedural, and metacognitive) is how people come to know and understand the world around them. Deep understanding develops through thinking and learning contextually, creatively, and critically in a variety of situations, both independently and with others.

Think and learn contextually • Apply prior knowledge, experiences, and the ideas of self and others in new contexts. • Analyze connections or relationships within and/or among ideas, experiences, or natural and constructed objects. • Recognize that a context is a complex whole made of parts. • Analyze a particular context for ways that parts influence each other and create the whole. • Explore norms*, concepts, situations, and experiences from several perspectives, theoretical frameworks, and worldviews.
Think and learn creatively • Show curiosity and interest in the world, new experiences, materials, and puzzling or surprising events. • Experiment with ideas, hypotheses, educated guesses, and intuitive thoughts. • Explore complex systems and issues using a variety of approaches such as models, simulations, movement, self-reflection, and inquiry. • Create or re-design objects, designs, models, patterns, relationships, or ideas by adding, changing, removing, combining, and separating elements. • Imagine and create central images or metaphors for subject area content or cross-disciplinary ideas.

Think and learn critically

- Analyze and critique objects, events, experiences, ideas, theories, expressions, situations, and other phenomena.
- Distinguish among facts, opinions, beliefs, and preferences.
- Apply various criteria to assess ideas, evidence, arguments, motives, and actions.
- Apply, evaluate, and respond to differing strategies for solving problems and making decisions.
- Analyze factors that influence self and others' assumptions and abilities to think deeply, clearly, and fairly.

*Norms can include unexamined privilege (i.e., unearned rights/entitlements/immunity/exemptions associated with being "normal") which creates a power imbalance gained by birth, social position, or concession and provides a particular context.

Developing Identity and Interdependence

(Related to CELs of Personal and Social Development and Technological Literacy)

Identity develops as an individual interacts with others and the environment, and learns from various life experiences. The development of a positive self-concept, the ability to live in harmony with others, and the capacity and aptitude to make responsible decisions about the natural and constructed world supports the concept of interdependence. The focus within this competency is to foster personal reflection and growth, care for others, and the ability to contribute to a sustainable future.

Understand, value, and care for oneself (intellectually, emotionally, physically, spiritually)

- Recognize that cultural and linguistic backgrounds, norms, and experiences influence identity, beliefs, values, and behaviours.
- Develop skills, understandings, and confidence to make conscious choices that contribute to the development of a healthy, positive self-identity.
- Analyze family, community, and societal influences (such as recognized and unrecognized privileges) on the development of identity.
- Demonstrate self-reliance, self-regulation, and the ability to act with integrity.
- Develop personal commitment and the capacity to advocate for self.

Understand, value, and care for others

- Demonstrate openmindedness* toward, and respect for all.
- Learn about various peoples and cultures.
- Recognize and respect that people have values and worldviews that may or may not align with one's own values and beliefs.
- Value the varied abilities and interests of individuals to make positive contributions to society.
- Advocate for the well-being of others.

Understand and value social, economic, and environmental interdependence and sustainability**

- Examine the influence of worldviews on one's understanding of interdependence in the natural and constructed world.
- Evaluate how sustainable development depends on the effective and complex interaction of social, environmental, and economic factors.
- Analyze how one's thinking, choices, and behaviours affect living and non-living things, now and in the future.
- Investigate the potential of individual and group actions and contributions to sustainable development.
- Demonstrate a commitment to behaviours that contribute to the well-being of the society, environment, and economy – locally, nationally, and globally.

*Openmindedness refers to a mind that is open to new ideas, and free from prejudice or bias in order to develop an "ethical space" between an existing idea and a new idea (Ermine).

**Sustainability refers to making informed decisions for the benefit of ourselves and others, now and for the future, and to act upon those decisions for social, economic, and environmental well-being.

Developing Literacies

(Related to CELs of Communication, Numeracy, Technological Literacy, and Independent Learning)

Literacies provide many ways to interpret the world and express understanding of it. Being literate involves applying interrelated knowledge, skills, and strategies to learn and communicate with others. Communication in a globalized world is increasingly multimodal. Communication and meaning making, therefore, require the use and understanding of multiple modes of representation. Each area of study develops disciplinary literacies (e.g., scientific, economic, physical, health, linguistic, numeric, aesthetic, technological, cultural) and requires the understanding and application of multiple literacies (i.e., the ability to understand, critically evaluate, and communicate in multiple meaning making systems) in order for students to participate fully in a constantly changing world.

Construct knowledge related to various literacies

- Acknowledge the importance of multiple literacies in everyday life.
- Understand that literacies can involve words, images, numbers, sounds, movements, and other representations and that these can have different interpretations and meanings.
- Examine the interrelationships between literacies and knowledge, culture, and values.
- Evaluate the ideas and information found in a variety of sources (e.g., people, databases, natural and constructed environments).
- Access and use appropriate technologies to investigate ideas and deepen understanding in all areas of study.

Explore and interpret the world using various literacies

- Inquire and make sense of ideas and experiences using a variety of strategies, perspectives, resources, and technologies.
- Select and critically evaluate information sources and tools (including digital) based on the appropriateness to specific tasks.
- Use various literacies to challenge and question understandings and interpretations.
- Interpret qualitative and quantitative data (including personally collected data) found in textual, aural, and visual information gathered from various media sources.
- Use ideas and technologies in ways that contribute to creating new insight.

Express understanding and communicate meaning using various literacies

- Create, compute, and communicate using a variety of materials, strategies, and technologies to express understanding of ideas and experiences.
- Respond responsibly and ethically to others using various literacies.
- Determine and use the languages, concepts, and processes that are particular to a discipline when developing ideas and presentations.
- Communicate ideas, experiences, and information in ways that are inclusive, understandable, and useful to others.
- Select and use appropriate technologies in order to communicate effectively and ethically.

Developing Social Responsibility

(Related to CELs of Communication, Critical and Creative Thinking, Personal and Social Development, and Independent Learning)

Social responsibility is the ability of people to contribute positively to their physical, social, and cultural environments. It requires an awareness of unique gifts and challenges among individuals and

communities and the resulting opportunities that can arise. It also requires participation with others in creating an ethical space* to engage in dialogue, address mutual concerns, and accomplish shared goals.

Use moral reasoning processes

- Evaluate the possible consequences of a course of action on self, others, and the environment in a particular situation.
- Consider the implications of a course of action when applied to other situations.
- Consistently apply fundamental moral values** such as "respect for all".
- Demonstrate a principle-based approach to moral reasoning.
- Examine how values and principles have been and continue to be used by persons and cultures to guide conduct and behaviour.

Engage in communitarian thinking and dialogue

- Model a balance in speaking, listening, and reflecting.
- Ensure that each person has an opportunity to contribute.
- Demonstrate courage to express differing perspectives in a constructive manner.
- Use consensus-building strategies to work towards shared understanding.
- Be sensitive to, and respectful of, diversity and different ways of participating.

Take social action

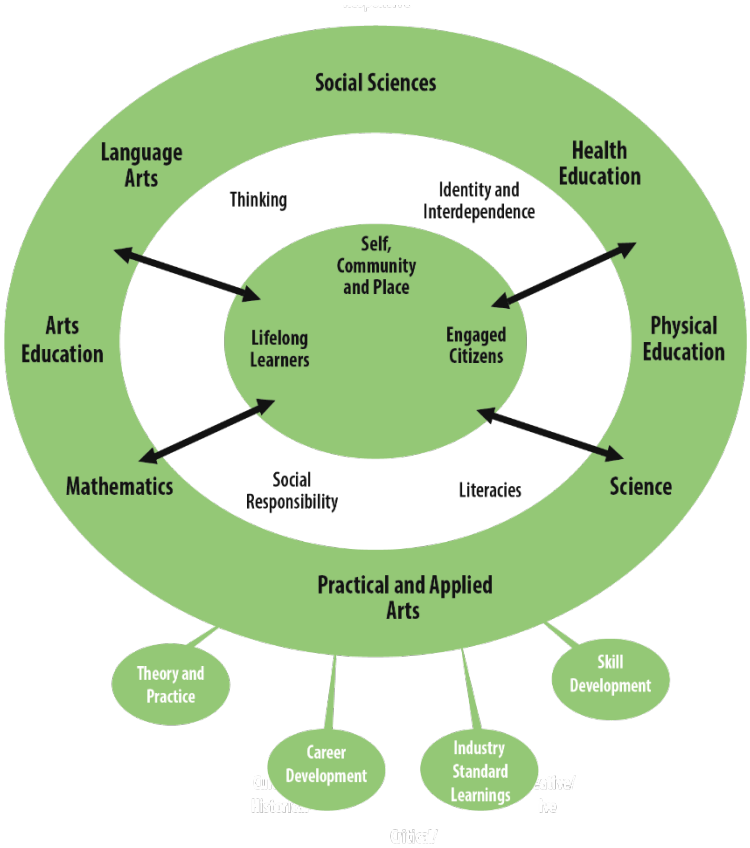
- Demonstrate respect for and commitment to human rights, treaty rights, and environmental sustainability.
- Contribute to harmony and conflict resolution in own classroom, school, family, and community.
- Provide support in a manner that is respectful of the needs, identity, culture, dignity, and capabilities of all persons.
- Support individuals in making contributions toward achieving a goal.
- Take responsible action to change perceived inequities or injustice for self and others.

*An ethical space exists between separate worldviews. In this space, "we can understand one another's knowledge systems" (Ermine, 2006). For further information, see Willie Ermine's work related to ethical space.

**The most basic moral value underlying development of the CEL of Personal and Social Development is that of respect for persons. For further discussion related to fundamental moral values, refer to *Understanding the Common Essential Learnings: A Handbook for Teachers* (1988, pages 42-49). See also the *Renewed Objectives for the CELs of Critical and Creative Thinking and Personal and Social Development* (2008).

Aim and Goals

The aim of 7-12 Practical and Applied Arts is to provide life skills to prepare students to participate as family members, community members, citizens, consumers and producers in Canadian society.



Goals are broad statements identifying what students are expected to know and be able to do upon completion of the learning in a particular area of study by the end of Grade 12. The goals of 7-12 Practical and Applied Arts are:

- **Theory and Practice** – Students will be engaged in a balance of theory and practice for lifelong learning.
- **Career Development** – Students will experience opportunities for career awareness, exploration and experience.
- **Industry Standard Learnings** – Students will gain industry standard learnings to assist them in accessing post-secondary education, training and employment.
- **Skill Development** – Students will develop the skills needed to enter, stay in and progress in the world of work.

Inquiry

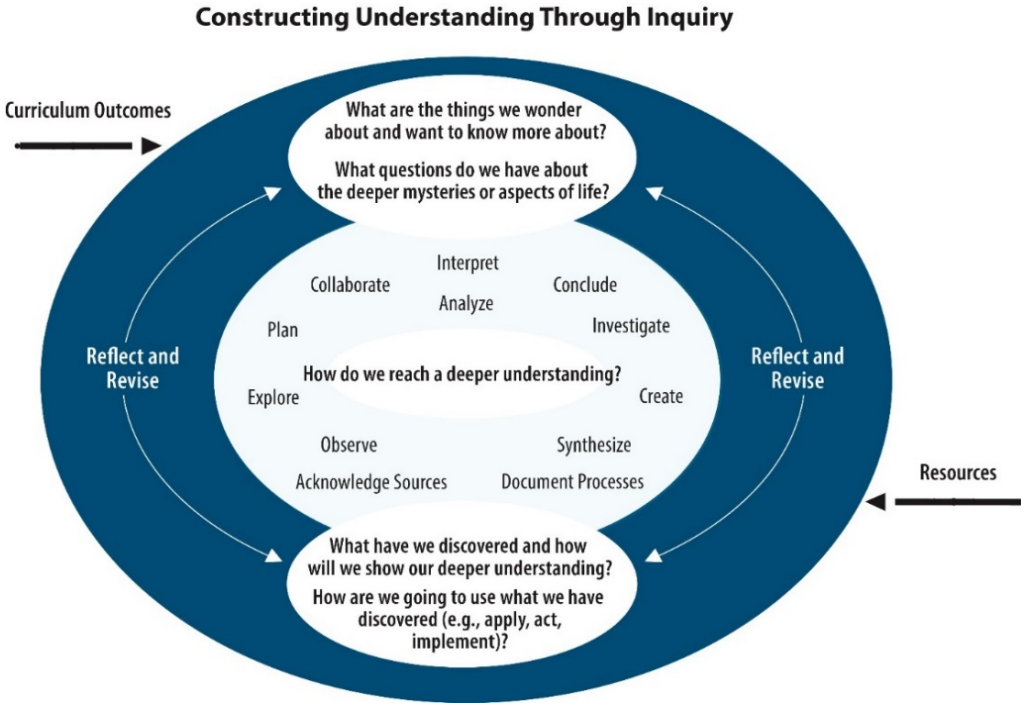
Inquiry learning provides students with opportunities to build knowledge, abilities and inquiring habits of mind that lead to deeper understanding of their world and human experience. Inquiry builds on students' inherent sense of curiosity and wonder, drawing on their diverse backgrounds, interests and experiences. The process provides opportunities for students to become active participants in a collaborative search for meaning and understanding.

"My teacher (Elder) liked it when I asked questions, this way it reassured him that I understood his teachings. He explained every detail, the meaning and purpose. Not only talked about it, but, showed me! Communication, critical and creative thinking were important." (Traditional Knowledge Keeper Albert Scott)

Students who are engaged in inquiry:

- construct deep knowledge and deep understanding, rather than passively receiving information;
- are directly involved and engaged in the discovery of new knowledge;
- encounter alternative perspectives and differing ideas that transform knowledge and experience into deep understandings;
- transfer new knowledge and skills to new circumstances; and,
- take ownership and responsibility for their ongoing learning and mastery of curriculum content and skills.

(Adapted from Kuhlthau, Maniotes, & Caspari, 2007)



In the Practical and Applied Arts, inquiry encompasses creating solutions to challenges through the practical application of understandings and skills. This includes processes to get from what is known to discover what is unknown. When teachers show students how to solve a challenge and then assign additional/similar challenges, the students are not constructing new knowledge through application but merely practising. Both are necessary elements of skill building in the Practical and Applied Arts, but one should not be confused with the other. If the path for getting to the end situation already has been determined, it is no longer problem solving. Students must understand this difference as well.

Inquiry learning is not a step-by-step process, but rather a cyclical process, with various phases of the process being revisited and rethought as a result of students' discoveries, insights and construction of new knowledge. Experienced inquirers will move back and forth among various phases as new questions arise and as students become more comfortable with the process. The following graphic shows various phases of the cyclical inquiry process.

An important part of any inquiry process is student reflection on their learning and the documentation needed to assess the learning and make it visible. Student documentation of the inquiry process may take the form of works-in-progress, reflective writing, journals, reports, notes, models, arts expressions, photographs, video footage, action plans and many more.

Creating Questions for Inquiry

It is important that teachers and students learn within meaningful contexts that relate to their lives, communities and world. Teachers and students need to identify big ideas and questions for deeper understanding central to the area of study.

Big ideas invoke inquiry questions. These questions are important in developing a deep understanding of the discipline or an area of study within the discipline. They do not have obvious answers and they foster high-order thinking. They invite genuine inquiry.

It is important to develop questions that are evoked by student interests and sense of wonder and have potential for rich and deep learning. These questions are used to initiate and guide inquiries that lead to deep understandings about topics, problems, ideas, challenges, issues, concepts and areas of study related to curriculum content and outcomes.

Well-formulated inquiry questions are broad in scope and rich in possibilities. Such questions encourage students to explore, observe, gather information, plan, analyze, interpret, synthesize, problem solve, take risks, create, conclude, document, reflect on learning and develop new questions for further inquiry.

The process of constructing questions for deep understanding can help student grasp the important disciplinary or interdisciplinary ideas that are situated at the core of a particular curricular focus or context. These broad questions lead to more specific questions that can provide a framework, purpose and direction for the learning activities in a lesson, or series of lessons, and help student connect what they are learning to their experiences and life beyond school.

Effective questions in Practical and Applied Arts are the key to initiating and guiding students' investigations, critical thinking, problem solving, and reflection on their own learning. Such questions include:

- What is the best solution to solving a particular robotics challenge?
- How can I refine my code to be clearer, less cumbersome and yet ensure my robotic device works as intended?
- How can design thinking help inform the process of designing a robotic device to solve a particular problem?

The above are only a few examples of questions to move students' inquiry towards deeper understanding. Effective questioning is essential for teaching and student learning, and should be an integral part of planning. Questioning should also be used to encourage students to reflect on the inquiry process and on the documentation and assessment of their own learning.

An Effective Practical and Applied Arts Program

An effective Practical and Applied Arts program provides a variety of relevant, engaging and authentic learning opportunities that are driven by student interest and facilitated through school- and work-based learning with linkages that connect the two. The course offerings emphasize:

- relevance to real life;
- hands-on learning;
- career development opportunities;
- industry standard learnings;
- connections to community; and,
- alignment with labour market needs.

Relevance to real life – Whether students enroll in PAA courses to develop skills for personal use, gain entry level employment skills or pursue post-secondary education or training such as apprenticeship, learning must be contextualized to help them see the application and relevance to the real world.

Hands-on learning – Hands-on learning gives students the opportunity to practice what they have learned using equipment and materials commonly found in the home, community or workplace. A balance between theory and practice enhances students' learning experiences.

Career development opportunities – All three levels of the career development continuum—awareness, exploration and experiential—should be supported. Students grow in their awareness of personal traits, skills and preferences that influence career decisions and in their awareness of occupational and career pathways. They explore many opportunities and may begin to experience careers firsthand through specialized work placements or classroom learning that support the refinement of skills related to a particular job or occupation. Opportunities for students to acquire industry certifications will help to enhance their employment opportunities.

Industry standard learnings – Integral to PAA curricula are industry standard learnings that ensure student learning is up-to-date and relevant to current industry standards and practices. These learnings can assist students in accessing post-secondary education as well as training and employment opportunities.

Connections to community - Students recognize the importance of their efforts when they apply their knowledge, skills and abilities to support creative and innovative community projects; they become engaged citizens making a positive contribution. Likewise, work placements within the community help to connect school- with work-based learning. Community professionals serving as mentors can encourage students to expand their career interests and to work towards achieving their career goals.

Alignment with labour market needs – Students can quickly see the importance and relevance of their learning when learning in PAA courses aligns with community labour market trends and opportunities.

Using this Curriculum

Outcomes define what students are expected to know, understand and be able to do by the end of a grade or secondary level course in a particular area of study. Outcomes provide direction for assessment and evaluation, and for program, unit and lesson planning. In PAA, outcomes that are required are those within core modules for pure courses, and those within optional modules selected at the local level.

Outcomes:

- focus on what students will learn rather than what teachers will teach;
- specify the skills, abilities, knowledge and/or attitudes students are expected to demonstrate;
- are observable, assessable and attainable; and,
- are supported by indicators which provide the breadth and depth of expectations.

Indicators are representative of what students need to know and/or be able to do in order to achieve an outcome. When planning for instruction, teachers must comprehend the set of indicators to understand fully the breadth and the depth of learning related to a particular outcome. Based on this understanding of the outcome, teachers may develop indicators that are responsive to students' needs, interests and prior learning. Teacher-developed indicators must maintain the intent of the outcome.

The set of indicators for an outcome:

- provides the intent (breadth and depth) of the outcome;
- tells the story, or creates a picture, of the outcome;
- defines the level and types of knowledge required; and,
- is not a checklist or prioritized list of instructional activities or assessment items.

Other Terms

Within curricula, the terms "including", "such as", "e.g." and "i.e." serve specific purposes:

- **Including** prescribes content, contexts or strategies that students must experience in their learning, without excluding other possibilities.
- **Such as** provides examples of possible broad categories of content, contexts or strategies that teachers or students may choose, without excluding other possibilities.
- **E.g.** offers specific examples of what a term, concept or strategy might look like.
- **I.e.** means 'that is' and clarifies the term, concept or strategy it follows.

Modules/Outcomes at a Glance

Legend: A = autonomous **RC** = radio controlled **B** = both

Focus	Module #	Modules/Outcomes	Level	Suggested Time (hrs)
Introductory Modules				
B	ROBA1	**Module 1: General Safety (Core)** Apply principles and techniques for injury prevention to ensure safe work area.	Introductory	2-4
B	ROBA2	**Module 2: History of Robotics (Core)** Investigate the historical development of robotics and autonomous technologies.	Introductory	1-2
B	ROBA3	**Module 3: Ethics and Laws (Core)** Explore ethical, moral and legal issues relevant to robotics and autonomous devices.	Introductory	2-3
B	ROBA4	**Module 4: Societal Impact (Core)** Evaluate historical and contemporary impacts of robotics and autonomous devices on society.	Introductory	2-3
B	ROBA5	**Module 5: Introduction to Automation (Optional)** Investigate the prevalence and societal impacts of automation.	Introductory	3-5
B	ROBA6	**Module 6: Artificial Intelligence (Optional)** Examine applications of artificial intelligence (AI) in robotics and automation.	Introductory	2-3
B	ROBA7A	**Module 7A: Troubleshooting A (Optional)** Develop and implement a plan to resolve an issue present in a device.	Introductory	3-5
B	ROBA7B	**Module 7B: Troubleshooting B (Optional)** Develop and implement a plan to resolve multiple issues present in a device.	Advanced	5-10

Design Thinking Modules				
B	ROBA8A	**Module 8A: Design Thinking A (Optional)** Apply engineering design processes to improve simple tasks and projects.	Introductory	2-4
B	ROBA8B	**Module 8B: Design Thinking B (Optional)** Evaluate a prototype using specific criteria.	Intermediate	1-2
B	ROBA8C	**Module 8C: Design Thinking C (Optional)** Incorporate empathy into engineering design processes.	Intermediate	4-5
Electrical Modules				
B	ROBA9	**Module 9: Electrical Safety (Optional)** Demonstrate safe practices when working with electricity and electrical devices.	Intermediate	1-2
B	ROBA10	**Module 10: Debugging Circuits (Optional)** Explore different strategies and conventions for debugging circuits.	Introductory	1-2
B	ROBA11	**Module 11: Electrical Theory (Optional)** Analyze the relationships among voltage, current and resistance in electrical circuits.	Intermediate	2-3
B	ROBA12A	**Module 12A: Basic Electricity A (Core)** Design and construct a variety of complex circuits.	Introductory	3-5
B	ROBA12B	**Module 12B: Basic Electricity B (Optional)** Analyze the differences between parallel and series circuits.	Introductory	3-5
A	ROBA13A	**Module 13A: Solderless Breadboards A (Optional)** Design and construct functional circuits on a breadboard.	Introductory	1-2
A	ROBA13B	**Module 13B: Solderless Breadboards B (Optional)** Apply advanced breadboarding knowledge and schematic diagrams to design and construct functional circuits on a breadboard.	Advanced	3-7

B	ROBA14A	**Module 14A: Electronic Components A (Optional)** Explore the use of resistors and light-emitting diodes (LEDs) in electric circuits.	Introductory	2-4
B	ROBA14B	**Module 14B: Electronic Components B (Optional)** Explore the use of component parts in basic electronic circuits.	Intermediate	2-4
B	ROBA14C	**Module 14C: Electronic Components C (Optional)** Design a variety of circuits to interface between a programmable control board and devices and a robotic or automated device.	Advanced	2-4
B	ROBA15A	**Module 15A: Drawing Circuits A (Optional)** Utilize wiring diagrams to guide the design and construction of electronic circuits.	Introductory	2-3
B	ROBA15B	**Module 15B: Drawing Circuits B (Optional)** Utilize schematic diagrams to guide the design and construction of electronic circuits.	Intermediate	2-3
B	ROBA16	**Module 16: Measuring Instruments (Optional)** Use a multimeter to measure voltage, current and resistance of a circuit or portion of a circuit.	Intermediate	2-3
B	ROBA17	**Module 17: Conductors and Insulators (Optional)** Explore how conductors and insulators are used in electric circuits.	Intermediate	2-3
B	ROBA18	**Module 18: Fuses (Optional)** Explore types and uses of fuses to protect circuits.	Introductory	1-2
B	ROBA19	**Module 19: Soldering (Optional)** Demonstrate proficiency in soldering.	Introductory	4-8
B	ROBA20	**Module 20: Datasheets (Optional)** Examine the importance of datasheets for understanding the technical characteristics of electronic components.	Advanced	2

Autonomous Modules				
A	ROBA21	**Module 21: Hardware / Software Interface (Optional)** Investigate the role of software in providing instructions to a robotic or automated device.	Introductory	2-5
A	ROBA22	**Module 22: Microcontrollers (Optional)** Investigate the role of a microcontroller in robotics and automation systems.	Introductory	3-5
A	ROBA23A	**Module 23A: Output A (Optional)** Design, construct and program a device to modify simple outputs.	Introductory	3-5
A	ROBA23B	**Module 23B: Output B (Optional)** Design, construct and program a device to modify multiple outputs.	Intermediate	3-5
A	ROBA24	**Module 24: Shields (Optional)** Explore the role of a shield in enhancing the functionality of microcontrollers.	Introductory	3-5
Coding Modules				
A	ROBA25	**Module 25: File Management (Optional)** Demonstrate effective file management and organization including the use of appropriate naming conventions and folder structures.	Introductory	1-2
A	ROBA26	**Module 26: Computational Thinking (Optional)** Investigate computational thinking as a problem-solving process.	Introductory	1-2
A	ROBA27	**Module 27: Pseudocode (Optional)** Examine the role of pseudocode in planning computer programs.	Intermediate	1-2
A	ROBA28A	**Module 28A: Block-Based Coding A (Optional)** Explore programming concepts using a block-based language.	Introductory	3-5

A	ROBA28B	**Module 28B: Block-Based Coding B (Optional)** Implement a program which utilizes control structures and repetition in a block-based coding environment.	Introductory	3-5
A	ROBA29	**Module 29: Syntax and Organization (Optional)** Demonstrate proper syntax and organization when developing a program.	Introductory	1-2
A	ROBA30A	**Module 30A: Coding – Variables A (Core)** Differentiate between common data types (e.g., integer, Boolean, floating point and string).	Introductory	5-10
A	ROBA30B	**Module 30B: Coding – Variables B (Core)** Create programs that use control structures to affect program flow.	Introductory	5-10
A	ROBA30C	**Module 30C: Coding – Variables C (Optional)** Explore the use of integer data types in programs.	Intermediate	8-10
A	ROBA30D	**Module 30D: Coding – Variables D (Optional)** Incorporate Boolean and string data types in programs.	Intermediate	3-15
A	ROBA30E	**Module 30E: Coding – Variables E (Optional)** Investigate the use of floating point data types in programs.	Intermediate	2-5
A	ROBA31A	**Module 31A: Coding – Control Structures A (Optional)** Create programs that use control structures to affect program flow.	Introductory	5-10
A	ROBA31B	**Module 31B: Coding – Control Structures B (Optional)** Create programs that use conditional statements to control program flow.	Intermediate	5-10
A	ROBA32A	**Module 32A: Coding – Functions A (Optional)** Create and incorporate functions in programs.	Intermediate	3-5

A	ROBA32B	**Module 32B: Coding – Functions B (Optional)** Incorporate internal, external and user-defined libraries to extend the functionality of software.	Intermediate	3-5
A	ROBA32C	**Module 32C: Coding – Functions C (Optional)** Investigate how and when to incorporate recursive functions into programs.	Advanced	3-5
A	ROBA33	**Module 33: Debugging Code (Optional)** Use common coding techniques to enhance code elegance and debug errors.	Intermediate	2-5
Sensor Modules				
A	ROBA34A	**Module 34A: Sensor Theory A (Optional)** Explore the use of sensors in robotic and automated devices.	Introductory	2-4
A	ROBA34B	**Module 34B: Sensor Theory B (Optional)** Investigate how sensors interact with hardware and software in a device.	Advanced	2-3
A	ROBA35A	**Module 35A: Line Sensors A (Optional)** Construct and program a device capable of following a simple line.	Introductory	3-5
A	ROBA35B	**Module 35B: Line Sensors B (Optional)** Construct and program a device capable of following a line that includes 90-degree turns and T-junctions.	Intermediate	3-5
A	ROBA35C	**Module 35C: Line Sensors C (Optional)** Construct and program a device capable of following a complex line, including dotted line sections.	Advanced	3-5
A	ROBA36A	**Module 36A: Tactile Sensors A (Optional)** Construct and program a device capable of using tactile sensors to make decisions.	Introductory	3-5
A	ROBA36B	**Module 36B: Tactile Sensors B (Optional)** Construct and program a device capable of using multiple tactile sensors to make decisions.	Intermediate	3-5

A	ROBA37A	**Module 37A: Ultrasonic Sensors A (Optional)** Construct and program a device that uses an ultrasonic sensor to detect distance.	Introductory	3-5
A	ROBA37B	**Module 37B: Ultrasonic Sensors B (Optional)** Construct and program a device that uses an ultrasonic sensor to navigate an area.	Intermediate	3-5
A	ROBA37C	**Module 37C: Ultrasonic Sensors C (Optional)** Construct and program a device that uses multiple ultrasonic sensors to make decisions.	Advanced	3-5
A	ROBA38A	**Module 38A: Infrared Sensors A (Optional)** Construct and program a device that uses infrared lights and sensors to detect objects.	Introductory	3-5
A	ROBA38B	**Module 38B: Infrared Sensors B (Optional)** Construct and program a device capable of navigating around a room using infrared sensors.	Intermediate	3-5
A	ROBA38C	**Module 38C: Infrared Sensors C (Optional)** Construct and program a device that uses multiple infrared sensors to make decisions.	Advanced	3-5
A	ROBA39A	**Module 39A: Sound Sensors A (Optional)** Construct and program a device that can detect sound using a sound sensor.	Introductory	3-5
A	ROBA39B	**Module 39B: Sound Sensors B (Optional)** Construct and program a device that can follow sound.	Intermediate	3-5
A	ROBA40A	**Module 40A: Other Sensors A (Optional)** Construct and program a device to detect an input from a sensor.	Introductory	3-5
A	ROBA40B	**Module 40B: Other Sensors B (Optional)** Construct and program a device that uses a different sensor (not ultrasonic, infrared, sound, line following or tactile) to perform an associated task.	Intermediate	3-5
A	ROBA41A	**Module 41A: Wearable Technologies A (Optional)** Investigate the use of wearable technologies.	Introductory	2-4

A	ROBA41B	**Module 41B: Wearable Technologies B (Optional)** Construct and program a wearable device.	Intermediate	5-10
A	ROBA42	**Module 42: Radio-Frequency Identification (Optional)** Construct and program a device that uses radio-frequency identification (RFID) to accomplish a specific task.	Intermediate	3-5
Radio Controlled (R/C) Modules				
RC	ROBA43A	**Module 43A: Transmitting and Receiving A (Optional)** Connect transmitting and receiving devices.	Introductory	2-4
RC	ROBA43B	**Module 43B: Transmitting and Receiving B (Optional)** Control a robotic or automated device using transmitting and receiving devices.	Intermediate	3-5
RC	ROBA43C	**Module 43C: Transmitting and Receiving C (Optional)** Customize a transmitter for control of a robotic or automated device.	Advanced	3-5
B	ROBA44A	**Module 44A: Power Sources A (Optional)** Examine a variety of power sources suitable for robotic and automation applications.	Introductory	2-4
B	ROBA44B	**Module 44B: Power Sources B (Optional)** Analyze different types of batteries for their suitability in robotics and automation applications.	Intermediate	3-5
B	ROBA45	**Module 45: Drive Systems (Optional)** Evaluate drive systems for suitability in robotics and automation applications.	Introductory	3-8
B	ROBA46	**Module 46: Wheels (Optional)** Evaluate wheels for suitability in robotics and automation applications.	Introductory	2-4

B	ROBA47	**Module 47: Gears (Optional)** Evaluate the suitability of gears, sprockets and chains and pulleys and belts for robotics and automation applications.	Intermediate	3-5
B	ROBA48	**Module 48: Motors (Optional)** Experiment with the properties and capabilities of direct current (DC) motors.	Introductory	3-5
B	ROBA49	**Module 49: Servos (Optional)** Investigate applications of servos in robotics and automation applications.	Introductory	3-5
B	ROBA50	**Module 50: Stepper Motors (Optional)** Explore applications of stepper motors in robotics and automation applications.	Advanced	3-5
B	ROBA51A	**Module 51A: Actuators A (Optional)** Experiment with the properties and capabilities of actuators.	Intermediate	2-4
B	ROBA51B	**Module 51B: Actuators B (Optional)** Design and construct a device that incorporates an actuator.	Intermediate	5-10
B	ROBA52A	**Module 52A: Motor Controllers A (Optional)** Use motor controllers to power motors.	Introductory	2-4
B	ROBA52B	**Module 52B: Motor Controllers B (Optional)** Assess the use of different motor controllers with specific motor types.	Intermediate	2-4
RC	ROBA53A	**Module 53A: Drones A (Optional)** Research and follow requirements for operating drones in Canada.	Intermediate	4-5
B	ROBA53B	**Module 53B: Drones B (Optional)** Design, construct and control a flying drone.	Intermediate	4-5
B	ROBA53C	**Module 53C: Drones C (Optional)** Design, construct and safely control a flying drone.	Advanced	5-10

Machining Modules				
B	ROBA54	**Module 54: Machine Safety (Optional)** Demonstrate safe practices when working with properly maintained mechanical equipment.	Intermediate	1-2
B	ROBA55	**Module 55: Properties of Materials (Optional)** Analyze the properties of materials and experiment with their uses in robotics and automation projects.	Introductory	2-3
B	ROBA56	**Module 56: Fasteners (Optional)** Use fasteners and adhesives effectively in a robotics and automation project.	Introductory	1-2
B	ROBA57	**Module 57: Mechanical Structure (Core)** Investigate mechanical structure techniques for use in robotics and automation applications.	Introductory	3-6
B	ROBA58A	**Module 58A: Fabricate A (Optional)** Modify existing parts for use in a device.	Introductory	2-3
B	ROBA58B	**Module 58B: Fabricate B (Optional)** Design and create a single part for use in a device.	Intermediate	2-3
B	ROBA58C	**Module 58C: Fabricate C (Optional)** Design and build a multi-part device.	Advanced	3-5
B	ROBA59	**Module 59: 3D CAD Basics (Optional)** Create representations of 3-dimensional (3D) objects using computer-aided design (CAD) software.	Introductory	3-8
B	ROBA60A	**Module 60A: 3D Printing A (Optional)** Construct an object using a 3-dimensional (3D) printing process.	Intermediate	5-10
B	ROBA60B	**Module 60B: 3D Printing B (Optional)** Design a 3D printed object to solve a problem encountered in robotics and automation applications.	Intermediate	5-10
B	ROBA61A	**Module 61A: CNC Manufacturing A (Optional)** Construct two-dimensional (2D) objects using computer numerical control (CNC) manufacturing.	Intermediate	5-10

B	ROBA61B	**Module 61B: CNC Manufacturing B (Optional)** Construct three-dimensional (3D) objects using computer numerical control (CNC) manufacturing.	Advanced	5-10
B	ROBA62A	**Module 62A: Fluid Power A (Optional)** Construct a mechanical device that incorporates principles of fluid power systems.	Introductory	1-2
B	ROBA62B	**Module 62B: Fluid Power B (Optional)** Design and build hydraulic and/or pneumatic components or systems.	Intermediate	3-5
Automation Modules				
A	ROBA63A	**Module 63A: Automation A (Optional)** Construct a simple automated device.	Intermediate	10-15
A	ROBA63B	**Module 63B: Automation B (Optional)** Construct an intermediate automated device.	Intermediate	10-20
A	ROBA63C	**Module 63C: Automation C (Optional)** Construct a complex automated device.	Advanced	10-20
A	ROBA64	**Module 64: Machine Vision (Optional)** Investigate the use of machine vision in robotics and automation applications.	Advanced	5-10
Project Management Modules				
B	ROBA65	**Module 65: Physical Space Management (Optional)** Evaluate workspace organization for effectiveness and efficiency.	Introductory	1-2
B	ROBA66A	**Module 66A: Project Management A (Optional)** Create, follow and manage a basic project plan.	Introductory	1-2
B	ROBA66B	**Module 66B: Project Management B (Optional)** Create, follow and manage a multi-step project plan.	Intermediate	1-2
B	ROBA66C	**Module 66C: Project Management C (Optional)** Design, implement and manage a detailed project plan that utilizes team member strengths and interests.	Advanced	3-5

B	ROBA67A	**Module 67A: Introductory Project (Optional)** Construct an introductory level assigned or approved robotics or automation project.	Introductory	10-20
B	ROBA67B	**Module 67B: Intermediate Project (Optional)** Construct an intermediate level assigned or approved robotics or automation project.	Intermediate	20-30
B	ROBA67C	**Module 67C: Advanced Project (Optional)** Construct an advanced level assigned or approved robotics or automation project.	Advanced	30-50
Career and Workplace Modules				
B	ROBA68A	**Module 68A: Careers in Robotics/Automation A (Core)** Explore robotics and automation career paths in Saskatchewan, Canada and the world.	Introductory	3-4
B	ROBA68B	**Module 68B: Careers in Robotics/Automation B (Core)** Examine the skills necessary to pursue robotics and/or automation related career paths.	Intermediate	3-4
B	ROBA68C	**Module 68C: Careers in Robotics/Automation C (Core)** Research robotics related career paths in Saskatchewan, Canada and the world.	Advanced	3-4
Work Study Modules				
B	ROBA69A	**Module 69A: Work Study Preparation (Optional)** Prepare for the work placement.	Intermediate	3-5
B	ROBA69B	**Module 69B: Work Study Preparation (Optional)** Prepare for the work placement.	Advanced	3-5
B	ROBA70A	**Module 70A: Work Study Placement (Optional)** Participate in a work placement experience.	Intermediate	25-50
B	ROBA70B	**Module 70B: Work Study Placement (Optional)** Participate in a work placement experience.	Advanced	25-50

B	ROBA71A	**Module 71A: Work Study Follow-up (Optional)** Relate one's work placement experience to personal and career goals.	Intermediate	2-4
B	ROBA71B	**Module 71B: Work Study Follow-up (Optional)** Relate one's work placement experience to personal and career goals.	Advanced	2-4
Extended Study Modules				
B	ROBA99A	**Module 99A: Extended Study (Optional)**	Introductory	10-25
B	ROBA99B	**Module 99B: Extended Study (Optional)**	Intermediate	10-25
B	ROBA99C	**Module 99C: Extended Study (Optional)**	Advanced	10-25

Course Configurations – Core and Suggested Optional Modules

Module #	Robotics and Automation 10 Autonomous Focus	Level	Suggested Time (hrs)
ROBA1	**Module 1: General Safety (Core)** Apply principles and techniques for injury prevention to ensure safe work area.	Introductory	2-4
ROBA2	**Module 2: History of Robotics (Core)** Investigate the historical development of robotics and autonomous technologies.	Introductory	1-2
ROBA7A	**Module 7A: Troubleshooting A (Optional)** Develop and implement a plan to resolve an issue present in a device.	Introductory	3-5
ROBA8A	**Module 8A: Design Thinking A (Optional)** Apply engineering design processes to improve simple tasks and projects.	Introductory	2-4
ROBA9	**Module 9: Electrical Safety (Optional)** Demonstrate safe practices when working with electricity and electrical devices.	Intermediate	1-2
ROBA10	**Module 10: Debugging Circuits (Optional)** Explore different strategies and conventions for debugging circuits.	Introductory	1-2
ROBA12A	**Module 12A: Basic Electricity A (Core)** Design and construct a variety of complex circuits.	Introductory	3-5
ROBA13A	**Module 13A: Solderless Breadboards A (Optional)** Design and construct functional circuits on a breadboard.	Introductory	1-2
ROBA14A	**Module 14A: Electronic Components A (Optional)** Explore the use of resistors and light-emitting diodes (LEDs) in electric circuits.	Introductory	2-4
ROBA15A	**Module 15A: Drawing Circuits A (Optional)** Utilize wiring diagrams to guide the design and construction of electronic circuits.	Introductory	2-3
ROBA16	**Module 16: Measuring Instruments (Optional)** Use a multimeter to measure voltage, current and resistance of a circuit or portion of a circuit.	Intermediate	2-3
ROBA19	**Module 19: Soldering (Optional)** Demonstrate proficiency in soldering.	Introductory	4-8

ROBA21	**Module 21: Hardware / Software Interface (Optional)** Investigate the role of software in providing instructions to a robotic or automated device.	Introductory	2-5
ROBA22	**Module 22: Microcontrollers (Optional)** Investigate the role of a microcontroller in robotics and automation systems.	Introductory	3-5
ROBA23A	**Module 23A: Output A (Optional)** Design, construct and program a device to modify simple outputs.	Introductory	3-5
ROBA25	**Module 25: File Management (Optional)** Demonstrate effective file management and organization including the use of appropriate naming conventions and folder structures.	Introductory	1-2
ROBA27	**Module 27: Pseudocode B (Optional)** Examine the role of pseudocode in planning computer programs.	Introductory	1-2
ROBA30A	**Module 30A: Coding – Variables A (Core)** Differentiate between common data types (e.g., integer, Boolean, floating point and string).	Introductory	1-3
ROBA30B	**Module 30B: Coding – Variables B (Core)** Create programs that use control structures to affect program flow.	Introductory	1-3
ROBA31A	**Module 31A: Coding – Control Structures A (Optional)** Create programs that use control structures to affect program flow.	Introductory	5-10
ROBA33	**Module 33: Debugging Code (Optional)** Use common coding techniques to enhance code elegance and debug errors.	Intermediate	2-5
ROBA34A	**Module 34A: Sensor Theory A (Optional)** Explore the use of sensors in robotic and automated devices.	Introductory	2-4
ROBA35A	**Module 35A: Line Sensors A (Optional)** Construct and program a device capable of following a simple line.	Introductory	3-5
ROBA36A	**Module 36A: Tactile Sensors A (Optional)** Construct and program a device capable of using tactile sensors to make decisions.	Introductory	3-5
ROBA37A	**Module 37A: Ultrasonic Sensors A (Optional)** Construct and program a device that uses an ultrasonic sensor to detect distance.	Introductory	3-5

ROBA38A	**Module 38A: Infrared Sensors A (Optional)** Construct and program a device that uses infrared lights and sensors to detect objects.	Introductory	3-5
ROBA39A	**Module 39A: Sound Sensors A (Optional)** Construct and program a device that can detect sound using a sound sensor.	Introductory	3-5
ROBA40A	**Module 40A: Other Sensors A (Optional)** Construct and program a device to detect an input from a sensor.	Introductory	3-5
ROBA41A	**Module 41A: Wearable Technologies A (Optional)** Investigate the use of wearable technologies.	Introductory	2-4
ROBA41B	**Module 41B: Wearable Technologies B (Optional)** Construct and program a wearable device.	Intermediate	5-10
ROBA44A	**Module 44A: Power Sources A (Optional)** Examine a variety of power sources suitable for robotic and automation applications.	Introductory	2-4
ROBA48	**Module 48: Motors (Optional)** Experiment with the properties and capabilities of direct current (DC) motors.	Introductory	3-5
ROBA49	**Module 49: Servos (Optional)** Investigate applications of servos in robotics and automation applications.	Introductory	3-5
ROBA52A	**Module 52A: Motor Controllers A (Optional)** Use motor controllers to power motors.	Introductory	2-4
ROBA57	**Module 57: Mechanical Structure (Core)** Investigate mechanical structure techniques for use in robotics and automation applications.	Introductory	3-6
ROBA63A	**Module 63A: Automation A (Optional)** Construct a simple automated device.	Introductory	10-15
ROBA65	**Module 65: Physical Space Management (Optional)** Evaluate workspace organization for effectiveness and efficiency.	Introductory	1-2
ROBA66A	**Module 66A: Project Management A (Optional)** Create, follow and manage a basic project plan.	Introductory	1-2
ROBA67A	**Module 67A: Introductory Project (Optional)** Construct an introductory level assigned or approved robotics or automation project.	Introductory	10-20

ROBA68A	**Module 68A: Careers in Robotics/Automation A (Core)** Explore robotics and automation career paths in Saskatchewan, Canada and the world.	Introductory	3-4
ROBA99A	**Extended Study (Optional)**	Introductory	10-25
	Minimum		**100**
Module #	**Robotics and Automation 10 Radio-Control Focus**	**Level**	**Suggested Time (hrs)**
ROBA1	**Module 1: General Safety (Core)** Apply principles and techniques for injury prevention to ensure safe work area.	Introductory	2-4
ROBA2	**Module 2: History of Robotics (Core)** Investigate the historical development of robotics and autonomous technologies.	Introductory	1-2
ROBA7A	**Module 7A: Troubleshooting A (Optional)** Develop and implement a plan to resolve an issue present in a device.	Introductory	3-5
ROBA8A	**Module 8A: Design Thinking A (Optional)** Apply engineering design processes to improve simple tasks and projects.	Introductory	2-4
ROBA9	**Module 9: Electrical Safety (Optional)** Demonstrate safe practices when working with electricity and electrical devices.	Intermediate	1-2
ROBA10	**Module 10: Debugging Circuits (Optional)** Explore different strategies and conventions for debugging circuits.	Introductory	1-2
ROBA11	**Module 11: Electrical Theory (Optional)** Analyze the relationships among voltage, current and resistance in electrical circuits.	Intermediate	2-3
ROBA12A	**Module 12A: Basic Electricity A (Core)** Design and construct a variety of complex circuits.	Introductory	3-5
ROBA14A	**Module 14A: Electronic Components A (Optional)** Explore the use of resistors and light-emitting diodes (LEDs) in electric circuits.	Introductory	2-4
ROBA16	**Module 16: Measuring Instruments (Optional)** Use a multimeter to measure voltage, current and resistance of a circuit or portion of a circuit.	Intermediate	2-3
ROBA17	**Module 17: Conductors and Insulators (Optional)** Explore how conductors and insulators are used in electric circuits.	Intermediate	2-3

ROBA18	**Module 18: Fuses (Optional)** Explore types and uses of fuses to protect circuits.	Introductory	1-2
ROBA19	**Module 19: Soldering (Optional)** Demonstrate proficiency in soldering.	Introductory	4-8
ROBA22	**Module 22: Microcontrollers (Optional)** Investigate the role of a microcontroller in robotics and automation systems.	Introductory	3-5
ROBA23A	**Module 23A: Output A (Optional)** Design, construct and program a device to modify simple outputs.	Introductory	3-5
ROBA43A	**Module 43A: Transmitting and Receiving A (Optional)** Connect transmitting and receiving devices.	Introductory	2-4
ROBA44A	**Module 44A: Power Sources A (Optional)** Examine a variety of power sources suitable for robotic and automation applications.	Introductory	2-4
ROBA46	**Module 46: Wheels (Optional)** Evaluate wheels for suitability in robotics and automation applications.	Introductory	2-4
ROBA48	**Module 48: Motors (Optional)** Experiment with the properties and capabilities of direct current (DC) motors.	Introductory	3-5
ROBA49	**Module 49: Servos (Optional)** Investigate applications of servos in robotics and automation applications.	Introductory	3-5
ROBA51A	**Module 51A: Actuators A (Optional)** Experiment with the properties and capabilities of actuators.	Intermediate	2-4
ROBA52A	**Module 52A: Motor Controllers A (Optional)** Use motor controllers to power motors.	Introductory	2-4
ROBA56	**Module 56: Fasteners (Optional)** Use fasteners and adhesives effectively in a robotics and automation project.	Introductory	1-2
ROBA57	**Module 57: Mechanical Structure (Core)** Investigate mechanical structure techniques for use in robotics and automation applications.	Introductory	3-6
ROBA58A	**Module 58A: Fabricate A (Optional)** Modify existing parts for use in a device.	Introductory	2-3
ROBA65	**Module 65: Physical Space Management (Optional)** Evaluate workspace organization for effectiveness and efficiency.	Introductory	1-2

ROBA66A	**Module 66A: Project Management A (Optional)** Create, follow and manage a basic project plan.	Introductory	1-2
ROBA67A	**Module 67A: Introductory Project (Optional)** Construct an introductory level assigned or approved robotics or automation project.	Introductory	10-20
ROBA68A	**Module 68A: Careers in Robotics/Automation A (Core)** Explore robotics and automation career paths in Saskatchewan, Canada and the world.	Introductory	3-4
ROBA99A	**Extended Study (Optional)**	Introductory	10-25
Optional Modules from the Carpentry Curriculum			
COCA6	Module 6: Measuring and Layout		4-8
COCA7	Module 7: Hand Tools		4-8
COCA8A	Module 8A: Portable Power Tools		5-8
COCA9A	Module 9A: Stationary Power Tools		5-8
COCA10	Module 10: Fasteners and Adhesives		2-5
	Minimum		**100**

Module Code	Robotics and Automation 20 Autonomous Focus	Level	Suggested Time (hrs)
ROBA1	**Module 1: General Safety (Core)** Apply principles and techniques for injury prevention to ensure safe work area.	Introductory	2-4
ROBA3	**Module 3: Ethics and Laws (Core)** Explore ethical, moral and legal issues relevant to robotics and autonomous devices.	Introductory	2-3
ROBA4	**Module 4: Societal Impact (Core)** Evaluate historical and contemporary impacts of robotics and autonomous devices on society.	Introductory	2-3
ROBA5	**Module 5: Introduction to Automation (Optional)** Investigate the prevalence and societal impacts of automation.	Introductory	3-5
ROBA6	**Module 6: Artificial Intelligence (Optional)** Examine applications of artificial intelligence (AI) in robotics and automation.	Introductory	2-3
ROBA8B	**Module 8B: Design Thinking B (Optional)** Evaluate a prototype using specific criteria.	Intermediate	1-2
ROBA9	**Module 9: Electrical Safety (Optional)** Demonstrate safe practices when working with electricity and electrical devices.	Intermediate	1-2
ROBA12B	**Module 12B: Basic Electricity B (Optional)** Analyze the differences between parallel and series circuits.	Introductory	3-5
ROBA13B	**Module 13B: Solderless Breadboards B (Optional)** Apply advanced breadboarding knowledge and schematic diagrams to design and construct functional circuits on a breadboard.	Advanced	3-7
ROBA14B	**Module 14B: Electronic Components B (Optional)** Explore the use of component parts in basic electronic circuits.	Intermediate	2-4
ROBA15B	**Module 15B: Drawing Circuits B (Optional)** Utilize schematic diagrams to guide the design and construction of electronic circuits.	Intermediate	2-3
ROBA17	**Module 17: Conductors and Insulators (Optional)** Explore how conductors and insulators are used in electric circuits.	Intermediate	2-3

ROBA23B	**Module 23B: Output B (Optional)** Design, construct and program a device to modify multiple outputs.	Intermediate	3-5
ROBA24`	**Module 24: Shields (Optional)** Explore the role of a shield in enhancing the functionality of microcontrollers.	Introductory	3-5
ROBA26	**Module 26: Computational Thinking (Optional)** Investigate computational thinking as a problem-solving process.	Introductory	1-2
ROBA29	**Module 29: Syntax and Organization (Optional)** Demonstrate proper syntax and organization when developing a program.	Introductory	1-2
ROBA30C	**Module 30C: Coding – Variables C (Optional)** Explore the use of integer data types in programs.	Intermediate	1-3
ROBA30D	**Module 30D: Coding – Variables D (Optional)** Incorporate Boolean and string data types in programs.	Intermediate	1-3
ROBA30E	**Module 30E: Coding – Variables E (Optional)** Investigate the use of floating point data types in programs.	Intermediate	2-5
ROBA31B	**Module 31B: Coding – Control Structures B (Optional)** Create programs that use conditional statements to control program flow.	Intermediate	5-10
ROBA32A	**Module 32A: Coding – Functions A (Optional)** Create and incorporate functions in programs.	Intermediate	3-5
ROBA34B	**Module 34B: Sensor Theory B (Optional)** Investigate how sensors interact with hardware and software in a device.	Advanced	2-3
ROBA35B	**Module 35B: Line Sensors B (Optional)** Construct and program a device capable of following a line that includes 90-degree turns and T-junctions.	Intermediate	3-5
ROBA36B	**Module 36B: Tactile Sensors B (Optional)** Construct and program a device capable of using multiple tactile sensors to make decisions.	Intermediate	3-5
ROBA37B	**Module 37B: Ultrasonic Sensors B (Optional)** Construct and program a device that uses an ultrasonic sensor to navigate an area.	Intermediate	3-5
ROBA38B	**Module 38B: Infrared Sensors B (Optional)** Construct and program a device capable of navigating around a room using infrared sensors.	Intermediate	3-5

ROBA39B	**Module 39B: Sound Sensors B (Optional)** Construct and program a device that can follow sound.	Intermediate	3-5
ROBA40A	**Module 40A: Other Sensors A (Optional)** Construct and program a device to detect an input from a sensor.	Introductory	3-5
ROBA42	**Module 42: Radio-Frequency Identification (Optional)** Construct and program a device that uses radio-frequency identification (RFID) to accomplish a specific task.	Intermediate	3-5
ROBA53A	**Module 53A: Drones A (Optional)** Research and follow requirements for operating drones in Canada.	Intermediate	3-5
ROBA54	**Module 54: Machine Safety (Optional)** Demonstrate safe practices when working with properly maintained mechanical equipment.	Intermediate	1-2
ROBA58A	**Module 58A: Fabricate A (Optional)** Modify existing parts for use in a device.	Introductory	2-3
ROBA59	**Module 59: 3D CAD Basics (Optional)** Create representations of 3-dimensional (3D) objects using computer-aided design (CAD) software.	Introductory	3-8
ROBA60A	**Module 60A: 3D Printing A (Optional)** Construct an object using a 3-dimensional (3D) printing process.	Intermediate	5-10
ROBA63B	**Module 63B: Automation B (Optional)** Construct an intermediate automated device.	Intermediate	10-20
ROBA66B	**Module 66B: Project Management B (Optional)** Create, follow and manage a multi-step project plan.	Intermediate	1-2
ROBA67B	**Module 67B: Intermediate Project (Optional)** Construct an intermediate level assigned or approved robotics or automation project.	Intermediate	10-20
ROBA68B	**Module 68B: Careers in Robotics/Automation B (Core)** Examine the skills necessary to pursue robotics and/or automation related career paths.	Intermediate	3-4
ROBA69A	**Module 69A: Work Study Preparation (Optional)** Prepare for the work placement.	Intermediate	3-5
ROBA70A	**Module 70A: Work Study Placement (Optional)** Participate in a work placement experience.	Intermediate	25-50

ROBA71A	**Module 71A: Work Study Follow-up (Optional)** Relate one's work placement experience to personal and career goals.	Intermediate	2-4
ROBA99B	**Extended Study (Optional)**	Intermediate	10-25
	Minimum		**100**
Module Code	**Robotics and Automation 20 Radio Control Focus**	**Level**	**Suggested Time (hrs)**
ROBA1	**Module 1: General Safety (Core)** Apply principles and techniques for injury prevention to ensure safe work area.	Introductory	2-4
ROBA3	**Module 3: Ethics and Laws (Core)** Explore ethical, moral and legal issues relevant to robotics and autonomous devices.	Introductory	2-3
ROBA4	**Module 4: Societal Impact (Core)** Evaluate historical and contemporary impacts of robotics and autonomous devices on society.	Introductory	2-3
ROBA5	**Module 5: Introduction to Automation (Optional)** Investigate the prevalence and societal impacts of automation.	Introductory	3-5
ROBA6	**Module 6: Artificial Intelligence (Optional)** Examine applications of artificial intelligence (AI) in robotics and automation.	Introductory	2-3
ROBA8B	**Module 8B: Design Thinking B (Optional)** Evaluate a prototype using specific criteria.	Intermediate	1-2
ROBA9	**Module 9: Electrical Safety (Optional)** Demonstrate safe practices when working with electricity and electrical devices.	Intermediate	1-2
ROBA12B	**Module 12B: Basic Electricity B (Optional)** Analyze the differences between parallel and series circuits.	Introductory	3-5
ROBA14B	**Module 14B: Electronic Components B (Optional)** Explore the use of component parts in basic electronic circuits.	Intermediate	2-4
ROBA20	**Module 20: Datasheets (Optional)** Examine the importance of datasheets for understanding the technical characteristics of electronic components.	Advanced	2
ROBA23B	**Module 23B: Output B (Optional)** Design, construct and program a device to modify multiple outputs.	Intermediate	3-5

ROBA24	**Module 24: Shields (Optional)** Explore the role of a shield in enhancing the functionality of microcontrollers.	Introductory	3-5
ROBA43B	**Module 43B: Transmitting and Receiving B (Optional)** Control a robotic or automated device using transmitting and receiving devices.	Intermediate	3-5
ROBA44B	**Module 44B: Power Sources B (Optional)** Analyze different types of batteries for their suitability in robotics and automation applications.	Intermediate	3-5
ROBA45	**Module 45: Drive Systems (Optional)** Evaluate drive systems for suitability in robotics and automation applications.	Introductory	3-8
ROBA47	**Module 47: Gears (Optional)** Evaluate the suitability of gears, sprockets and chains and pulleys and belts for robotics and automation applications.	Intermediate	3-5
ROBA51B	**Module 51B: Actuators B (Optional)** Design and construct a device that incorporates an actuator.	Intermediate	5-10
ROBA52B	**Module 52B: Motor Controllers B (Optional)** Assess the use of different motor controllers with specific motor types.	Intermediate	2-4
ROBA53A	**Module 53A: Drones A (Optional)** Research and follow requirements for operating drones in Canada.	Intermediate	4-5
ROBA54	**Module 54: Machine Safety (Optional)** Demonstrate safe practices when working with properly maintained mechanical equipment.	Intermediate	1-2
ROBA55	**Module 55: Properties of Materials (Optional)** Analyze the properties of materials and experiment with their uses in robotics and automation projects.	Introductory	2-3
ROBA58B	**Module 58B: Fabricate B (Optional)** Design and create a single part for use in a device.	Intermediate	2-3
ROBA59	**Module 59: 3D CAD Basics (Optional)** Create representations of 3-dimensional (3D) objects using computer-aided design (CAD) software.	Introductory	3-8
ROBA60A	**Module 60A: 3D Printing A (Optional)** Construct an object using a 3-dimensional (3D) printing process.	Intermediate	5-10

ROBA66B	**Module 66B: Project Management B (Optional)** Create, follow and manage a multi-step project plan.	Intermediate	1-2
ROBA67B	**Module 67B: Intermediate Project (Optional)** Construct an intermediate level assigned or approved robotics or automation project.	Intermediate	10-20
ROBA68B	**Module 68B: Careers in Robotics/Automation B (Core)** Examine the skills necessary to pursue robotics and/or automation related career paths.	Intermediate	3-4
ROBA69A	**Module 69A: Work Study Preparation (Optional)** Prepare for the work placement.	Intermediate	3-5
ROBA70A	**Module 70A: Work Study Placement (Optional)** Participate in a work placement experience.	Intermediate	25-50
ROBA71A	**Module 71A: Work Study Follow-up (Optional)** Relate one's work placement experience to personal and career goals.	Intermediate	2-4
ROBA99B	**Extended Study (Optional)**	Intermediate	10-25
Optional Modules from the Welding Curriculum			
WLDG03	Module 3: Hand and Power Tools		3-15
WLDG05	Module 5: Oxyacetylene Start-up, Shut-down, and Cutting		3-5
WLDG13	Module 13: Plasma Arc Cutting		1-2
WLDG27A	Module 27A: GMAW Procedures and Practice		15-20
	Minimum		**100**

Module Code	Robotics and Automation 30 Autonomous Focus	Level	Suggested Time (hrs)
ROBA1	**Module 1: General Safety (Core)** Apply principles and techniques for injury prevention to ensure safe work area.	Introductory	2-4
ROBA7B	**Module 7B: Troubleshooting B (Optional)** Develop and implement a plan to resolve multiple issues present in a device.	Advanced	5-10
ROBA8C	**Module 8C: Design Thinking C (Optional)** Incorporate empathy into engineering design processes.	Intermediate	4-5
ROBA9	**Module 9: Electrical Safety (Optional)** Demonstrate safe practices when working with electricity and electrical devices.	Intermediate	1-2
ROBA14C	**Module 14C: Electronic Components C (Optional)** Design a variety of circuits to interface between a programmable control board and devices and a robotic or automated device.	Advanced	2-4
ROBA18	**Module 18: Fuses (Optional)** Explore types and uses of fuses to protect circuits.	Introductory	1-2
ROBA20	**Module 20: Datasheets (Optional)** Examine the importance of datasheets for understanding the technical characteristics of electronic components.	Advanced	2
ROBA32B	**Module 32B: Coding – Functions B (Optional)** Incorporate internal, external and user-defined libraries to extend the functionality of software.	Intermediate	3-5
ROBA32C	**Module 32C: Coding – Functions C (Optional)** Investigate how and when to incorporate recursive functions into programs.	Advanced	3-5
ROBA35C	**Module 35C: Line Sensors C (Optional)** Construct and program a device capable of following a complex line, including dotted line sections.	Advanced	3-5
ROBA37C	**Module 37C: Ultrasonic Sensors C (Optional)** Construct and program a device that uses multiple ultrasonic sensors to make decisions.	Advanced	3-5
ROBA38C	**Module 38C: Infrared Sensors C (Optional)** Construct and program a device that uses multiple infrared sensors to make decisions.	Advanced	3-5

ROBA53B	**Module 53B: Drones B (Optional)** Design, construct and control a flying drone.	Intermediate	5-7
ROBA53C	**Module 53C: Drones C (Optional)** Design, construct and safely control a flying drone.	Advanced	5-10
ROBA58B	**Module 58B: Fabricate B (Optional)** Design and create a single part for use in a device.	Intermediate	2-3
ROBA60B	**Module 60B: 3D Printing B (Optional)** Design a 3D printed object to solve a problem encountered in robotics and automation applications.	Intermediate	5-10
ROBA61A	**Module 61A: CNC Manufacturing A (Optional)** Construct two-dimensional (2D) objects using computer numerical control (CNC) manufacturing.	Intermediate	5-10
ROBA61B	**Module 61B: CNC Manufacturing B (Optional)** Construct three-dimensional (3D) objects using computer numerical control (CNC) manufacturing.	Advanced	5-10
ROBA62A	**Module 62A: Fluid Power A (Optional)** Construct a mechanical device that incorporates principles of fluid power systems.	Introductory	1-2
ROBA62B	**Module 62B: Fluid Power B (Optional)** Design and build hydraulic and/or pneumatic components or systems.	Intermediate	3-5
ROBA63C	**Module 63C: Automation C (Optional)** Construct a complex automated device.	Advanced	10-20
ROBA64	**Module 64: Machine Vision (Optional)** Investigate the use of machine vision in robotics and automation applications.	Advanced	5-10
ROBA66C	**Module 66C: Project Management C (Optional)** Design, implement and manage a detailed project plan that utilizes team member strengths and interests.	Advanced	3-5
ROBA67C	**Module 67C: Advanced Project (Optional)** Construct an advanced level assigned or approved robotics or automation project.	Advanced	30-50
ROBA68C	**Module 68C: Careers in Robotics/Automation C (Core)** Research robotics related career paths in Saskatchewan, Canada and the world.	Advanced	3-4
ROBA69B	**Module 69B: Work Study Preparation (Optional)** Prepare for the work placement.	Advanced	3-5
ROBA70B	**Module 70B: Work Study Placement (Optional)** Participate in a work placement experience.	Advanced	25-50

ROBA71B	**Module 71B: Work Study Follow-up (Optional)** Relate one's work placement experience to personal and career goals.	Advanced	2-4
ROBA99C	**Extended Study (Optional)**	Advanced	10-25
	Minimum		**100**
Module Code	**Robotics and Automation 30 Radio Control Focus**	**Level**	**Suggested Time (hrs)**
ROBA1	**Module 1: General Safety (Core)** Apply principles and techniques for injury prevention to ensure safe work area.	Introductory	2-4
ROBA7B	**Module 7B: Troubleshooting B (Optional)** Develop and implement a plan to resolve multiple issues present in a device.	Advanced	5-10
ROBA8C	**Module 8C: Design Thinking C (Optional)** Incorporate empathy into engineering design processes.	Intermediate	4-5
ROBA9	**Module 9: Electrical Safety (Optional)** Demonstrate safe practices when working with electricity and electrical devices.	Intermediate	1-2
ROBA14C	**Module 14C: Electronic Components C (Optional)** Design a variety of circuits to interface between a programmable control board and devices and a robotic or automated device.	Advanced	2-4
ROBA43C	**Module 43C: Transmitting and Receiving C (Optional)** Customize a transmitter for control of a robotic or automated device.	Advanced	3-5
ROBA50	**Module 50: Stepper Motors (Optional)** Explore applications of stepper motors in robotics and automation applications.	Advanced	3-5
ROBA53B	**Module 53B: Drones B (Optional)** Design, construct and control a flying drone.	Intermediate	5-7
ROBA53C	**Module 53C: Drones C (Optional)** Design, construct and safely control a flying drone.	Advanced	5-10
ROBA58C	**Module 58C: Fabricate C (Optional)** Design and build a multi-part device.	Advanced	3-5
ROBA60B	**Module 60B: 3D Printing B (Optional)** Design a 3D printed object to solve a problem encountered in robotics and automation applications.	Intermediate	5-10

ROBA61A	**Module 61A: CNC Manufacturing A (Optional)** Construct two-dimensional (2D) objects using computer numerical control (CNC) manufacturing.	Intermediate	5-10
ROBA61B	**Module 61B: CNC Manufacturing B (Optional)** Construct three-dimensional (3D) objects using computer numerical control (CNC) manufacturing.	Advanced	5-10
ROBA62B	**Module 62B: Fluid Power B (Optional)** Design and build hydraulic and/or pneumatic components or systems.	Intermediate	3-5
ROBA66C	**Module 66C: Project Management C (Optional)** Design, implement and manage a detailed project plan that utilizes team member strengths and interests.	Advanced	3-5
ROBA67C	**Module 67C: Advanced Project (Optional)** Construct an advanced level assigned or approved robotics or automation project.	Advanced	30-50
ROBA68C	**Module 68C: Careers in Robotics/Automation C (Core)** Research robotics related career paths in Saskatchewan, Canada and the world.	Advanced	3-4
ROBA69B	**Module 69B: Work Study Preparation (Optional)** Prepare for the work placement.	Advanced	3-5
ROBA70B	**Module 70B: Work Study Placement (Optional)** Participate in a work placement experience.	Advanced	25-50
ROBA71B	**Module 71B: Work Study Follow-up (Optional)** Relate one's work placement experience to personal and career goals.	Advanced	2-4
ROBA99C	**Extended Study (Optional)**	Advanced	10-25
	Minimum		**100**

Suggested Modules for Middle-Level PAA Survey Courses

Note: Survey courses at the Middle Level should incorporate primarily Introductory modules.

Module #	Module Name	Level	Suggested Time (hrs)	Prerequisite Module(s)
ROBA1	**Module 1: General Safety** Apply principles and techniques for injury prevention to ensure safe work area.	Introductory	2-4	None
ROBA2	**Module 2: History of Robotics** Investigate the historical development of robotics and autonomous technologies.	Introductory	1-2	None
ROBA7A	**Module 7A: Troubleshooting A** Develop and implement a plan to resolve an issue present in a device.	Introductory	3-5	None
ROBA8A	**Module 8A: Design Thinking A** Apply engineering design processes to improve simple tasks and projects.	Introductory	2-4	None
ROBA8B	**Module 8B: Design Thinking B** Evaluate a prototype using specific criteria.	Intermediate	1-2	8A
ROBA10	**Module 10: Debugging Circuits** Explore different strategies and conventions for debugging circuits.	Introductory	1-2	None
ROBA12A	**Module 12A: Basic Electricity A** Design and construct a variety of complex circuits.	Introductory	3-5	None
ROBA13A	**Module 13A: Solderless Breadboards A** Design and construct functional circuits on a breadboard.	Introductory	1-2	None
ROBA14A	**Module 14A: Electronic Components A** Explore the use of resistors and light-emitting diodes (LEDs) in electric circuits.	Introductory	2-4	None
ROBA15A	**Module 15A: Drawing Circuits A** Utilize wiring diagrams to guide the design and construction of electronic circuits.	Introductory	2-3	None
ROBA17	**Module 17: Conductors and Insulators** Explore how conductors and insulators are used in electric circuits.	Intermediate	2-3	None
ROBA19	**Module 19: Soldering** Demonstrate proficiency in soldering.	Introductory	4-8	1

ROBA21	**Module 21: Hardware / Software Interface** Investigate the role of software in providing instructions to a robotic or automated device.	Introductory	2-5	None
ROBA22	**Module 22: Microcontrollers** Investigate the role of a microcontroller in robotics and automation systems.	Introductory	3-5	None
ROBA23A	**Module 23A: Output A** Design, construct and program a device to modify simple outputs.	Introductory	3-5	None
ROBA23B	**Module 23B: Output B** Design, construct and program a device to modify multiple outputs.	Intermediate	3-5	23A
ROBA25	**Module 25: File Management (Optional)** Demonstrate effective file management and organization including the use of appropriate naming conventions and folder structures.	Introductory	1-2	None
ROBA26	**Module 26: Computational Thinking** Investigate computational thinking as a problem-solving process.	Introductory	1-2	None
ROBA27	**Module 27: Pseudocode** Examine the role of pseudocode in planning computer programs.	Intermediate	1-2	None
ROBA28A	**Module 28A: Block-Based Coding A** Explore programming concepts using a block-based language.	Introductory	3-5	None
ROBA28B	**Module 28B: Block-Based Coding B** Implement a program which utilizes control structures and repetition in a block-based coding environment.	Introductory	3-5	28A
ROBA30A	**Module 30A: Coding – Variables A** Differentiate between common data types (e.g., integer, Boolean, floating point and string).	Introductory	1-3	None
ROBA30B	**Module 30B: Coding – Variables B** Create programs that use control structures to affect program flow.	Introductory	1-3	30A
ROBA34A	**Module 34A: Sensor Theory A** Explore the use of sensors in robotic and automated devices.	Introductory	2-4	None

ROBA35A	**Module 35A: Line Sensors A** Construct and program a device capable of following a simple line.	Introductory	3-5	28A or 30A
ROBA36A	**Module 36A: Tactile Sensors A** Construct and program a device capable of using tactile sensors to make decisions.	Introductory	3-5	28A or 30A
ROBA37A	**Module 37A: Ultrasonic Sensors A** Construct and program a device that uses an ultrasonic sensor to detect distance.	Introductory	3-5	28A or 30A
ROBA38A	**Module 38A: Infrared Sensors A** Construct and program a device that uses infrared lights and sensors to detect objects.	Introductory	3-5	28A or 30A
ROBA39A	**Module 39A: Sound Sensors A** Construct and program a device that can detect sound using a sound sensor.	Introductory	3-5	28A or 30A
ROBA40A	**Module 40A: Other Sensors A** Construct and program a device to detect an input from a sensor.	Introductory	3-5	28A or 30A
ROBA41A	**Module 41A: Wearable Technologies A** Investigate the use of wearable technologies.	Introductory	2-4	None
ROBA41B	**Module 41B: Wearable Technologies B** Construct and program a wearable device.	Intermediate	5-10	41A
ROBA43A	**Module 43A: Transmitting and Receiving A** Connect transmitting and receiving devices.	Introductory	2-4	None
ROBA44A	**Module 44A: Power Sources A** Examine a variety of power sources suitable for robotic and automation applications.	Introductory	2-4	None
ROBA48	**Module 48: Motors** Experiment with the properties and capabilities of direct current (DC) motors.	Introductory	3-5	None
ROBA49	**Module 49: Servos** Investigate applications of servos in robotics and automation applications.	Introductory	3-5	None
ROBA55	**Module 55: Properties of Materials** Analyze the properties of materials and experiment with their uses in robotics and automation projects.	Introductory	2-3	None
ROBA56	**Module 56: Fasteners** Use fasteners and adhesives effectively in a robotics and automation project.	Introductory	1-2	None

ROBA57	**Module 57: Mechanical Structure** Investigate mechanical structure techniques for use in robotics and automation applications.	Introductory	3-6	None
ROBA58A	**Module 58A: Fabricate A** Modify existing parts for use in a device.	Introductory	2-3	None
ROBA59	**Module 59: 3D CAD Basics** Create representations of 3-dimensional (3D) objects using computer-aided design (CAD) software.	Introductory	3-8	None
ROBA60A	**Module 60A: 3D Printing A** Construct an object using a 3-dimensional (3D) printing process.	Intermediate	5-10	59
ROBA63A	**Module 63A: Automation A** Construct a simple automated device.	Intermediate	10-15	None
ROBA65	**Module 65: Physical Space Management** Evaluate workspace organization for effectiveness and efficiency.	Introductory	1-2	None
ROBA66A	**Module 66A: Project Management A** Create, follow and manage a basic project plan.	Introductory	1-2	None

Suggested Modules for Secondary PAA Survey Courses

Module #	Module Name	Level	Suggested Time (hrs)	Prerequisite Module(s)
ROBA1	**Module 1: General Safety** Apply principles and techniques for injury prevention to ensure safe work area.	Introductory	2-4	None
ROBA2	**Module 2: History of Robotics** Investigate the historical development of robotics and autonomous technologies.	Introductory	1-2	None
ROBA3	**Module 3: Ethics and Laws** Explore ethical, moral and legal issues relevant to robotics and autonomous devices.	Introductory	2-3	None
ROBA5	**Module 5: Introduction to Automation** Investigate the prevalence and societal impacts of automation.	Introductory	3-5	None
ROBA6	**Module 6: Artificial Intelligence** Examine applications of artificial intelligence (AI) in robotics and automation.	Introductory	2-3	None
ROBA7A	**Module 7A: Troubleshooting A** Develop and implement a plan to resolve an issue present in a device.	Introductory	3-5	None
ROBA8A	**Module 8A: Design Thinking A** Apply engineering design processes to improve simple tasks and projects.	Introductory	2-4	None
ROBA8B	**Module 8B: Design Thinking B** Evaluate a prototype using specific criteria.	Intermediate	1-2	8A
ROBA8C	**Module 8C: Design Thinking C** Incorporate empathy into engineering design processes.	Intermediate	4-5	8A
ROBA9	**Module 9: Electrical Safety** Demonstrate safe practices when working with electricity and electrical devices.	Intermediate	1-2	1
ROBA10	**Module 10: Debugging Circuits** Explore different strategies and conventions for debugging circuits.	Introductory	1-2	None
ROBA12A	**Module 12A: Basic Electricity A** Design and construct a variety of complex circuits.	Introductory	3-5	None
ROBA13A	**Module 13A: Solderless Breadboards A** Design and construct functional circuits on a breadboard.	Introductory	1-2	None

ROBA14A	**Module 14A: Electronic Components A** Explore the use of resistors and light-emitting diodes (LEDs) in electric circuits.	Introductory	2-4	None
ROBA15A	**Module 15A: Drawing Circuits A** Utilize wiring diagrams to guide the design and construction of electronic circuits.	Introductory	2-3	None
ROBA16	**Module 16: Measuring Instruments** Use a multimeter to measure voltage, current and resistance of a circuit or portion of a circuit.	Intermediate	2-3	11, 12A
ROBA17	**Module 17: Conductors and Insulators** Explore how conductors and insulators are used in electric circuits.	Intermediate	2-3	None
ROBA19	**Module 19: Soldering** Demonstrate proficiency in soldering.	Introductory	4-8	1
ROBA21	**Module 21: Hardware / Software Interface** Investigate the role of software in providing instructions to a robotic or automated device.	Introductory	2-5	None
ROBA22	**Module 22: Microcontrollers** Investigate the role of a microcontroller in robotics and automation systems.	Introductory	3-5	None
ROBA23A	**Module 23A: Output A** Design, construct and program a device to modify simple outputs.	Introductory	3-5	None
ROBA23B	**Module 23B: Output B** Design, construct and program a device to modify multiple outputs.	Intermediate	3-5	23A
ROBA25	**Module 25: File Management** Demonstrate effective file management and organization including the use of appropriate naming conventions and folder structures.	Introductory	1-2	None
ROBA26	**Module 26: Computational Thinking** Investigate computational thinking as a problem-solving process.	Introductory	1-2	None
ROBA27	**Module 27: Pseudocode** Examine the role of pseudocode in planning computer programs.	Intermediate	1-2	None
ROBA28A	**Module 28A: Block-Based Coding A** Explore programming concepts using a block-based language.	Introductory	3-5	None

ROBA28B	**Module 28B: Block-Based Coding B** Implement a program which utilizes control structures and repetition in a block-based coding environment.	Introductory	3-5	28A
ROBA29	**Module 29: Syntax and Organization** Demonstrate proper syntax and organization when developing a program.	Introductory	1-2	None
ROBA30A	**Module 30A: Coding – Variables A** Differentiate between common data types (e.g., integer, Boolean, floating point and string).	Introductory	1-3	None
ROBA30B	**Module 30B: Coding – Variables B** Create programs that use control structures to affect program flow.	Introductory	1-3	30A
ROBA31A	**Module 31A: Coding – Control Structures A** Create programs that use control structures to affect program flow.	Introductory	5-10	30A
ROBA31B	**Module 31B: Coding – Control Structures B** Create programs that use conditional statements to control program flow.	Intermediate	5-10	31A
ROBA33	**Module 33: Debugging Code** Use common coding techniques to enhance code elegance and debug errors.	Intermediate	2-5	30A
ROBA34A	**Module 34A: Sensor Theory A** Explore the use of sensors in robotic and automated devices.	Introductory	2-4	None
ROBA35A	**Module 35A: Line Sensors A** Construct and program a device capable of following a simple line.	Introductory	3-5	28A or 30A
ROBA35B	**Module 35B: Line Sensors B** Construct and program a device capable of following a line that includes 90-degree turns and T-junctions.	Intermediate	3-5	35A
ROBA36A	**Module 36A: Tactile Sensors A** Construct and program a device capable of using tactile sensors to make decisions.	Introductory	3-5	28A or 30A
ROBA36B	**Module 36B: Tactile Sensors B** Construct and program a device capable of using multiple tactile sensors to make decisions.	Intermediate	3-5	36A

ROBA37A	**Module 37A: Ultrasonic Sensors A** Construct and program a device that uses an ultrasonic sensor to detect distance.	Introductory	3-5	28A or 30A
ROBA37B	**Module 37B: Ultrasonic Sensors B** Construct and program a device that uses an ultrasonic sensor to navigate an area.	Intermediate	3-5	37A
ROBA38A	**Module 38A: Infrared Sensors A** Construct and program a device that uses infrared lights and sensors to detect objects.	Introductory	3-5	28A or 30A
ROBA38B	**Module 38B: Infrared Sensors B** Construct and program a device capable of navigating around a room using infrared sensors.	Intermediate	3-5	38A
ROBA39A	**Module 39A: Sound Sensors A** Construct and program a device that can detect sound using a sound sensor.	Introductory	3-5	28A or 30A
ROBA40A	**Module 40A: Other Sensors A** Construct and program a device to detect an input from a sensor.	Introductory	3-5	28A or 30A
ROBA41A	**Module 41A: Wearable Technologies A** Investigate the use of wearable technologies.	Introductory	2-4	None
ROBA41B	**Module 41B: Wearable Technologies B** Construct and program a wearable device.	Intermediate	5-10	41A
ROBA42	**Module 42: Radio-Frequency Identification** Construct and program a device that uses radio-frequency identification (RFID) to accomplish a specific task.	Intermediate	3-5	28A or 30A
ROBA43A	**Module 43A: Transmitting and Receiving A** Connect transmitting and receiving devices.	Introductory	2-4	None
ROBA43B	**Module 43B: Transmitting and Receiving B** Control a robotic or automated device using transmitting and receiving devices.	Intermediate	3-5	43A
ROBA44A	**Module 44A: Power Sources A** Examine a variety of power sources suitable for robotic and automation applications.	Introductory	2-4	None
ROBA45	**Module 45: Drive Systems** Evaluate drive systems for suitability in robotics and automation applications.	Introductory	3-8	None
ROBA46	**Module 46: Wheels** Evaluate wheels for suitability in robotics and automation applications.	Introductory	2-4	None

ROBA48	**Module 48: Motors** Experiment with the properties and capabilities of direct current (DC) motors.	Introductory	3-5	None
ROBA49	**Module 49: Servos** Investigate applications of servos in robotics and automation applications.	Introductory	3-5	None
ROBA52A	**Module 52A: Motor Controllers A** Use motor controllers to power motors.	Introductory	2-4	None
ROBA54	**Module 54: Machine Safety** Demonstrate safe practices when working with properly maintained mechanical equipment.	Intermediate	4-5	1
ROBA55	**Module 55: Properties of Materials** Analyze the properties of materials and experiment with their uses in robotics and automation projects.	Introductory	2-3	None
ROBA56	**Module 56: Fasteners** Use fasteners and adhesives effectively in a robotics and automation project.	Introductory	1-2	None
ROBA57	**Module 57: Mechanical Structure** Investigate mechanical structure techniques for use in robotics and automation applications.	Introductory	3-6	None
ROBA58A	**Module 58A: Fabricate A** Modify existing parts for use in a device.	Introductory	2-3	None
ROBA58B	**Module 58B: Fabricate B** Design and create a single part for use in a device.	Intermediate	2-3	58A
ROBA58C	**Module 58C: Fabricate C** Design and build a multi-part device.	Advanced	3-5	58B
ROBA59	**Module 59: 3D CAD Basics** Create representations of 3-dimensional (3D) objects using computer-aided design (CAD) software.	Introductory	3-8	None
ROBA60A	**Module 60A: 3D Printing A** Construct an object using a 3-dimensional (3D) printing process.	Intermediate	5-10	59
ROBA60B	**Module 60B: 3D Printing B** Design a 3D printed object to solve a problem encountered in robotics and automation applications.	Intermediate	5-10	60A

ROBA62A	**Module 62A: Fluid Power A** Construct a mechanical device that incorporates principles of fluid power systems.	Introductory	1-2	None
ROBA63A	**Module 63A: Automation A** Construct a simple automated device.	Intermediate	10-15	None
ROBA65	**Module 65: Physical Space Management** Evaluate workspace organization for effectiveness and efficiency.	Introductory	1-2	None
ROBA66A	**Module 66A: Project Management A** Create, follow and manage a basic project plan.	Introductory	1-2	None
ROBA68A	**Module 68A: Careers in Robotics/Automation A** Explore robotics and automation career paths in Saskatchewan, Canada and the world.	Introductory	3-4	None
ROBA69A	**Module 69A: Work Study Preparation** Prepare for the work placement.	Intermediate	3-5	None
ROBA69B	**Module 69B: Work Study Preparation** Prepare for the work placement.	Advanced	3-5	None
ROBA70A	**Module 70A: Work Study Placement** Participate in a work placement experience.	Intermediate	25-50	69A
ROBA70B	**Module 70B: Work Study Placement** Participate in a work placement experience.	Advanced	25-50	69B
ROBA71A	**Module 71A: Work Study Follow-up** Relate one's work placement experience to personal and career goals.	Intermediate	2-4	70A
ROBA71B	**Module 71B: Work Study Follow-up** Relate one's work placement experience to personal and career goals.	Advanced	2-4	70B
ROBA99A	**Module 99A: Extended Study**	Introductory	10-25	None
ROBA99B	**Module 99B: Extended Study**	Intermediate	10-25	None
ROBA99C	**Module 99C: Extended Study**	Advanced	10-25	None

Modules: Outcomes and Indicators

Module 1: General Safety (Core)		
Suggested Time:2-4	**Level: Introductory**	**Prerequisite: None**
Outcome	**Indicators**	
Apply principles and techniques for injury prevention to ensure safety in the work area.	a. Identify personal protective equipment (PPE) such as eyewear, clothing, footwear and earwear that may be needed for the work site, school or home. b. Apply accident prevention principles and techniques, and discuss appropriate actions in case of an injury or accident, such as whom to contact, fire extinguisher locations, emergency exit routes and first-aid procedures. c. Explain the purpose of ventilation in a confined environment. d. Practice good housekeeping and avoid obvious hazards (e.g., touching live wires, extending cords over walking spaces and leaving objects on the floor). e. Complete an assessment of all safety and robotics equipment and, in consultation with the instructor, perform maintenance to repair or replace defective or worn parts. f. Recognize and apply safe and fair work practices including freedom from violence, harassment and bullying.	
	Note: Safety must be the primary focus for students each day.	

Module 2: History of Robotics (Core)		
Suggested Time: 1-2 hours	**Level: Introductory**	**Prerequisite: None**
Outcome	**Indicators**	
Investigate the historical development of robotics and autonomous technologies.	a. Explore the history of robots and robotics. b. Identify characteristics common to all robots and robotic devices. c. Research and create a representation (e.g., timeline, infographic) of important dates in the history of robotics and autonomous devices. d. Explain the criteria generally associated with autonomous devices, including different levels of autonomy. e. Provide examples of contemporary applications of robotic and autonomous devices, used in industry, manufacturing, agriculture, mining, healthcare, military and for general purposes. f. Research a recent development in robotics or autonomous devices. g. Describe tasks that are suitable for robotics and autonomous devices. h. Predict future trends in robotics and autonomous devices.	

Module 3: Ethics and Laws (Core)		
Suggested Time: 2-3 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Explore ethical, moral and legal issues relevant to robotics and autonomous devices.	a. Discuss how the ethics of robotic and autonomous devices have been portrayed in the media, particularly in science fiction (e.g., *2001: A Space Odyssey*). b. Discuss legal and/or ethical perspectives with regards to fault when a robotic or autonomous device causes harm to a person, property or nature. c. Discuss the theoretical relevance of Asimov's Laws of Robotics to contemporary applications of robotics and artificial intelligence. d. Analyze case studies (e.g., *The Case of the Killer Robot* by Richard G. Epstein) or news reports of accidents involving death or injury caused by industrial robots and discuss who is considered at fault. e. Research current and proposed legislation involving the personal and commercial use of drones. f. Hypothesize about the possibility that robots or devices with artificial intelligence will be able to make their own decisions and the potential ramifications of this ability. g. Discuss moral implications (e.g., racial profiling, choosing who lives or dies, unemployment and robot rights, the Trolley problem and unintended consequences) related to artificially intelligent robotic and autonomous devices.

Module 4: Societal Impact (Core)		
Suggested Time: 2-3 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Evaluate historical and contemporary impacts of robotics and autonomous devices on society.	a. Explore the uses of robotics in the field of medicine for applications such as surgery, rehabilitation and remote diagnosis. b. Analyze how movies (e.g., "*I, Robot*" and "*Short Circuit*") about robots portray the effects of robot interaction on humanity and the role of work in the future. c. Explore societal implications of the increasing prevalence of robotic and autonomous devices in our daily lives and routines. d. Assess potential positive and negative impacts of robotics on various industries (e.g., automotive manufacturing, agriculture and mining). e. Analyze how artificial intelligence can impact robotics and autonomous devices. f. Evaluate the impact of a specific application of artificial intelligence. g. Debate an issue related to autonomous devices such as the viability of driverless vehicles of varying levels of autonomy on public highways and private worksites.

Module 5: Introduction to Automation (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Investigate the prevalence and societal impacts of automation.	a. Differentiate between robotics and automation. b. Research the use of automation in a variety of fields, such as retail, healthcare, food services, mining, waste management, industry, manufacturing, logistics, automotive and in the home. c. Identify the main advantages of automation. d. Critique the use of automation in our society, including current and potential effects of automation on society and the environment. e. Explore issues (e.g., human input, mechanical wear, technical programming) arising with automation.

Module 6: Artificial Intelligence (Optional)		
Suggested Time: 2-3 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Examine applications of artificial intelligence (AI) in robotics and automation.	a. Research the evolving understanding of the concept of artificial intelligence. b. Discuss how to identify whether a robotic or automated device is considered to have or display artificial intelligence. c. Analyze how devices with artificial intelligence work differently than controlled or autonomous devices and robots. d. Discuss the interrelationships between automation, machine learning and artificial intelligence, within the context of robotics and autonomous devices. e. Examine the extent to which artificial intelligence can or cannot exceed or replace human ability in regards to certain tasks (e.g., game-playing computers, self-driving cars and personal assistants). f. Examine current limitations of artificial intelligence (e.g., machine learning is based on human instructions and data sets, data sets can perpetuate bias, learning must be supervised). g. Investigate the ways in which machine learning applications make use of different types of datasets (e.g., image data and facial recognition, text data and news article searches, physical data and astronomy). h. Explore potential applications for machine learning and artificial intelligence in robotics and automation.

Module 7A: Troubleshooting A (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: None**
Outcome	**Indicators**	
Develop and implement a plan to resolve an issue present in a device.	a. Identify and locate an underlying issue present in a device. b. Analyze the cause of an issue present in a device. c. Develop a plan to resolve an issue present in a device. d. Implement the plan to resolve an issue present in a device. e. Evaluate the effectiveness of the resolution and modify the plan as needed to resolve the issue.	

Module 7B: Troubleshooting B (Optional)		
Suggested Time: 5-10 hours	**Level: Advanced**	**Prerequisite: Module 7A**
Outcome	**Indicators**	
Develop and implement a plan to resolve multiple issues present in a device.	a. Identify and locate all issues present in a device, including programming and physical issues. b. Isolate all issues present in a device. c. Analyze the cause of all issues present in a device. d. Develop and evaluate a plan to resolve all issues present in a device. e. Implement a plan to resolve the issues present in a device. f. Evaluate the effectiveness of the resolutions and modify the plan as needed to resolve the issues. g. Discuss the need for having troubleshooting skills in various careers in the fields of robotics and automation.	

Module 8A: Design Thinking A (Optional)		
Suggested Time: 2-4 hours	**Level: Introductory**	**Prerequisite: None**
Outcome	**Indicators**	
Apply engineering design processes to improve simple tasks and projects.	a. Identify steps common to engineering design processes. b. Create a representation of engineering design processes to be used in simple tasks. c. Discuss the importance of iteration (e.g., ideate, design, prototype, test and redesign) in engineering design processes. d. Utilize engineering design processes (with a focus on iteration) to solve an engineering problem. e. Apply engineering design processes to simple robotics and automation tasks.	

Module 8B: Design Thinking B (Optional)		
Suggested Time: 1-2 hours	**Level: Intermediate**	**Prerequisite: Module 8A**

Outcome	Indicators
Evaluate a prototype using specific criteria.	a. Develop measurable success criteria for evaluating a project. b. Identify the type of feedback (e.g., coaching, praise and evaluation) desired from others. c. Develop procedures for seeking critical feedback from other designers and end users. d. Collect appropriate feedback from other designers and end users. e. Test one's prototype against end-user generated success criteria and identify areas for improvement.

Module 8C: Design Thinking C (Optional)		
Suggested Time: 4-5 hours	**Level: Intermediate**	**Prerequisite: Module 8A**

Outcome	Indicators
Incorporate empathy into engineering design processes.	a. Construct a problem definition empathizing with the needs and wants of the end user(s) for the project. b. Apply empathetic interview skills (e.g., ask why 3 times, encourage stories, ask open ended questions, pay attention to non-verbal cues and look for inconsistencies) to determine the needs and wants of the end user(s). c. Reflect on whether proposed solutions address actual versus perceived problems. d. Share project progress with the end user(s) at regular intervals to elicit feedback and ensure the project is meeting their needs.

Module 9: Electrical Safety (Optional)		
Suggested Time: 1-2 hours	**Level: Intermediate**	**Prerequisite: Module 1**

Outcome	Indicators
Demonstrate safe practices when working with electricity and electrical devices.	c. Explain the purpose of ventilation in a confined environment when working with electrical devices such as a soldering iron. d. Review safety procedures (e.g., inspect equipment for damaged or frayed wires, ensure proper grounding and ensure work area is free from liquids) for working with electrical equipment. e. Understand the need for circuit protection in an electrical circuit. f. Identify basic electrical hazards in the shop and/or work area. g. Inspect all tools and electrical equipment, including extension cords, for hazards before using them. h. Identify safe current and/or voltage values pertaining to equipment safety. i. Identify safe current and/or voltage values pertaining to personal safety.
	Note: Safety must be the primary focus for students each day.

Module 10: Debugging Circuits (Optional)		
Suggested Time: 1-2 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Incorporate appropriate strategies and conventions for debugging circuits.	a. Follow a standard colour convection (e.g., white is signal, negative is black and red is positive) when assigning wires for different purposes. b. Organize electrical and electronic components and make all connections in a neat and tidy manner. c. Develop and follow a test strategy for debugging each sub circuit. d. Debug a non-working circuit, following a step-by-step process and considering questions such as: • Did you build the circuit as described in your circuit diagram or schematic? • Is there power to your circuit? • Have you exceeded the limitations of any component? • Are all terminals receiving the correct voltage and polarity? • Are there any short circuits? • Is the logic of the circuit correct?

Module 11: Electrical Theory (Optional)		
Suggested Time: 2-3 hours	**Level: Intermediate**	**Prerequisite: None**

Outcome	Indicators
Analyze the relationships among voltage, current and resistance in electrical circuits.	a. Explain the difference between alternating current [AC] and direct current [DC] and when each is suitable for various applications. b. Calculate values of unknown quantities (e.g., current, voltage and resistance) in electric circuits using Ohm's Law (Current [I] = Voltage [V]/Resistance [R]). c. Calculate values of unknown quantities in electric circuits using Watt's Law (Power [W] = Voltage [V] x Current [I]).

Module 12A: Basic Electricity A (Core)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Design and construct a variety of electrical circuits.	a. Identify the components of an electric circuit. b. Differentiate between a closed, open, and short circuit. c. Discuss how to build circuits and how to avoid short circuits. d. Construct circuits that contains loads in parallel. e. Construct circuits that contains loads in series. f. Compare how switches control loads in series and parallel circuits. g. Construct parallel and/or series circuits that can be controlled by a microcontroller.

Module 12B: Basic Electricity B (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: Module 11, 12A**

Outcome	Indicators
Analyze the differences between parallel and series circuits.	a. Compare a variety of electrical pathways by constructing simple circuits. b. Construct and test various combinations of simple electric circuits to determine similarities and differences between series and parallel circuits. c. Construct combination circuits that incorporate both series and parallel pathways.

Module 13A: Solderless Breadboards A (Optional)		
Suggested Time: 1-2 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Design and construct functional circuits on a breadboard.	a. Identify the anatomy of a breadboard. b. Discuss the advantages of using breadboards to construct electronic circuits. c. Construct an electronic circuit based on a pictorial or wiring diagram. d. Draw a pictorial or wiring diagram to represent a physical breadboard assembly. e. Demonstrate the proper way of installing a variety of components (e.g., integrated circuits, button switches, wires and resistors) onto a breadboard. f. Demonstrate effective layout of components and connections on a breadboard to facilitate debugging and modification of circuits. g. Establish and follow standard wiring colour conventions (e.g., red is positive, black is negative, white or yellow is signal and green is ground) when using breadboards.

Module 13B: Solderless Breadboards B (Optional)		
Suggested Time: 3-7 hours	**Level: Advanced**	**Prerequisite: Module 12B: Solderless Breadboards A**

Outcome	Indicators
Apply advanced breadboarding knowledge and schematics diagrams to design and construct functional circuits on a breadboard.	a. Construct a circuit based on schematic diagrams that represent the elements on a breadboard. b. Draw a schematic diagram based on a breadboard assembly. c. Design and construct a robotic and/or autonomous device using a breadboard and a schematic diagram.

Module 14A: Electronic Components A (Optional)		
Suggested Time: 2-4 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Explore the use of resistors and light-emitting diodes (LEDs) in electronic circuits.	a. Describe the types (e.g., carbon and surface mount) of resistors commonly used in electronic circuits. b. Identify the value of a resistor by its colour code. c. Calculate the resistance at various points in series and parallel circuits. d. Identify the different types (e.g., through-hole, surface mount, bi-colour, RGB and high power) of LEDs. e. Describe the characteristics and current and voltage requirements of LEDs. f. Design and construct a simple circuit to power multiple LEDs. g. Design and construct a simple LED circuit that can be controlled via a program.

Module 14B: Electronic Components B (Optional)		
Suggested Time: 2-4 hours	**Level: Intermediate**	**Prerequisite: Module 14A**

Outcome	Indicators
Explore the use of diodes and other components in electronic circuits.	a. Draw and describe the parts of a diode. b. Describe the basic function of a diode, including polarity and the direction of electron flow through the diode. c. Identify the anode and cathode of a diode. d. Observe the effect of changing the direction of orientation of the diode in a low voltage DC circuit that includes an output device such as an LED. e. Explore the similarities between diodes and LEDs. f. Compare and contrast various conductors and their properties for use in circuits, including wire types, sizes, functions and limitations. g. Explore the usage of a potentiometer in a circuit. h. Explore the usage of a transistor in a circuit.

Module 14C: Electronic Components C (Optional)		
Suggested Time: 2-4 hours	**Level: Advanced**	**Prerequisite: Module 14B**

Outcome	Indicators
Design and construct a variety of circuits to interface between a programmable control board and a robotic or automated device.	a. List some advantages and disadvantages of using integrated circuits rather than conventional circuits in robotic and automated devices. b. Differentiate between NPN and PNP transistors. c. Design and construct a circuit that uses a transistor circuit (e.g., 5-5-5 timer) to control a higher current device. d. Design and construct a motor control circuit (e.g., H-Bridge) using an integrated circuit (IC) or transistor. e. Design and construct a complex circuit that is composed of multiple simple circuits and that contains inputs and outputs. f. Design and construct a servo control circuit using an integrated circuit (IC). g. Design and construct a circuit, such as a 3D cube, that will allow for the control of multiple light-emitting diodes (LEDs).

Module 15A: Drawing Circuits A (Optional)		
Suggested Time: 2-3 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Utilize wiring diagrams to guide the design and construction of electronic circuits.	a. Discuss the advantages of representing electric circuits using wiring diagrams and pictorial diagrams. b. Construct an electronic circuit using a wiring diagram as a guide. c. Create a wiring diagram for an electronic circuit using pencil and paper or appropriate software.

Module 15B: Drawing Circuits B (Optional)		
Suggested Time:2-3 hours	**Level: Intermediate**	**Prerequisite: Module 15A**

Outcome	Indicators
Utilize schematic diagrams to guide the design and construction of electronic circuits.	a. Discuss the advantages and disadvantages of representing electronic circuits using schematic diagrams rather than wiring diagrams. b. Identify common symbols used in schematic diagrams for electronic circuits. c. Construct a wired circuit using a schematic diagram as a guide. d. Draw a schematic diagram for a circuit containing no more than five components. e. Draw a schematic diagram for a circuit containing multiple simple circuits. f. Model, using appropriate standard circuit diagram symbols, series and parallel circuits that include an energy source, one or more switches, and various loads designed to accomplish specific tasks.

Module 16: Measuring Instruments (Optional)		
Suggested Time: 2-3 hours	**Level: Intermediate**	**Prerequisite: Module 11, 12A**

Outcome	Indicators
Use a multimeter to measure voltage, current and resistance of a circuit or portion of a circuit.	a. Connect a multimeter correctly to measure voltage and current in direct current (DC) circuits. b. Measure the resistance of a load in a circuit using a multimeter. c. Choose the correct scale to measure the current of a load, the voltage drop across a load and the resistance of a load in an electrical circuit. d. Identify potential sources of error in instrument readings. e. Measure the current load and voltage drop in a circuit.

Module 17: Conductors and Insulators (Optional)		
Suggested Time: 2-3 hours	**Level: Intermediate**	**Prerequisite: None**

Outcome	Indicators
Explore how conductors and insulators are used in electric circuits.	a. Differentiate between conductors and insulators. b. List materials that can be used as conductors. c. List materials that can be used as insulators. d. Calculate the gauge of conductor needed for a given current load.

Module 18: Fuses (Optional)		
Suggested Time: 1-2 hours	**Level: Introductory**	**Prerequisite: Module 1**

Outcome	Indicators
Explore how fuses are used to protect circuits.	a. Discuss what it means for a circuit to be overloaded. b. Discuss what occurs in a circuit that is experiencing a short circuit situation. c. Explain the use of different fuse types (e.g., plug fuses, cartridge fuses, time-delay fuses and renewable fuses). d. Explore how fuses should be wired in an electrical circuit. e. Troubleshoot a circuit with a fuse in it using a multimeter. f. Calculate the fuse rating for a given circuit.

Module 19: Soldering (Optional)		
Suggested Time: 4-8 hours	**Level: Introductory**	**Prerequisite: Module 1**

Outcome	Indicators
Demonstrate proficiency in soldering.	a. Compare the use of soldering irons and heat guns for effective use in different situations. b. Describe the function of flux when soldering. c. Execute proper soldering and desoldering techniques. d. Assess the quality of soldered connections.

Module 20: Datasheets (Optional)		
Suggested Time: 2 hours	**Level: Advanced**	**Prerequisite: Module 14B**

Outcome	Indicators
Examine the importance of datasheets for providing information about the technical characteristics of electronic components.	a. Discuss what datasheets (or spec sheets) are and their purposes in robotics construction. b. Indicate where datasheets for electronic components can be found. c. Extrapolate data from given datasheets. d. Using information from a datasheet, determine the proper parameters for a given electronic component to be used in a project.

Module 21: Hardware / Software Interface (Optional)		
Suggested Time: 2-5 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Investigate the role of software in providing instructions to a robotic or automated device.	a. Recognize that computer instructions (code) are written using software. b. Recognize that an Integrated Development Environment (IDE) is a software application which allows a user to enter code which is then compiled into a file. c. Download and run software (e.g., Arduino, BASICstamp or any integrated development environment [IDE]) to program a device. d. Reuse (copy and paste) a program in an IDE and transfer it to a physical device. e. Create a file from code that can be transferred to hardware. f. Connect hardware components and troubleshoot connection issues. g. Alter values (e.g., colour and sound) in a program and identify resulting impacts on hardware after re-transferring the program to device.

Module 22: Microcontrollers (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Investigate the role of microcontrollers in robotics and automation systems.	a. Explain the operation of typical microcontroller components (e.g., microprocessor, memory and input/output pins). b. Provide examples of different types of analog and digital input/output pins that may be found on a microcontroller. c. Critique different microcontrollers for functionality and usages. d. Identify the limitations of a microcontroller, including maximum current and input and output voltage ranges. e. Investigate how a microcontroller controls inputs and outputs. f. Investigate how to control a microcontroller. g. Research the use of microcontrollers in autonomous devices other than robots.

Module 23A: Output A (Optional)			
Suggested Time: 3-5 hours		**Level: Introductory**	**Prerequisite: None**
Outcome	**Indicators**		
Design, construct and program a device to deliver and/or modify simple outputs.	a. Recognize what constitutes an output (e.g., motor signal, servo signal, LED, speaker, text and movement) in the context of robotics and automated devices. b. Contrast the term output with the term input. c. Attach and wire output devices (e.g., LED, speaker, LCD and relay) properly. d. Develop and implement a program that delivers and/or modifies an output (e.g., light an LED, beep a speaker or display a message on an LCD).		

Module 23B: Output B (Optional)			
Suggested Time: 3-5 hours		**Level: Intermediate**	**Prerequisite: Module 23A**
Outcome	**Indicators**		
Design, construct and program a device to deliver and/or modify multiple outputs.	a. Construct a device that makes use of multiple outputs simultaneously. b. Develop a program that delivers and/or modifies an output (e.g., light an LED, beep a speaker or display a message on an LCD) to multiple output devices simultaneously. c. Inquire into the limits of a program and device to deliver and control multiple outputs at once.		

Module 24: Shields (Optional)			
Suggested Time: 3-5 hours		**Level: Introductory**	Prerequisite: Module 22
Outcome	**Indicators**		
Explore the role of shields in enhancing the functionality of microcontrollers.	a. Define shield in the context of microcontrollers. b. Describe the advantages and disadvantages of using shields to enhance the functionality of microcontrollers. c. Identify scenarios when shields, such as motor controllers, servo controllers and prototyping shields, can enhance the functionality of a microcontroller. d. Investigate how a shield interacts with a microcontroller. e. Critique the functionality and usages of various shields (e.g., motor shield, Bluetooth shield and prototype shield).		

Module 25: File Management (Optional)		
Suggested Time: 1-2 hours	**Level: Intermediate**	**Prerequisite: None**

Outcome	Indicators
Demonstrate effective file management and organization, including the use of appropriate naming conventions and folder structures.	a. Create and maintain a folder structure to organize computer files. b. Create and use a naming convention that organizes files by project and version number. c. Access shared files and manage file sharing with a team when required. d. Establish personal and team file editing protocols (e.g., storing files on a shared drive, file checkout/check in and using a local copy to experiment).

Module 26: Computational Thinking (Optional)		
Suggested Time: 1-2 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Investigate computational thinking as a problem-solving process.	a. Discuss how computational thinking concepts (e.g., logic, decomposition, pattern recognition, abstraction and algorithm design) can provide a framework for solving problems. b. Apply computational thinking concepts to solve coding and robotics and automation problems. c. Assess the extent to which computational thinking concepts were used in solving a coding or robotics and automation problem.

Module 27: Pseudocode (Optional)		
Suggested Time: 1-2 hours	**Level: Intermediate**	**Prerequisite: None**

Outcome	Indicators
Examine the role of pseudocode in planning computer programs.	a. Differentiate between pseudocode, natural language and a programming language. b. Explain the syntax and guidelines typically associated with pseudocode. c. Discuss the benefits of using pseudocode when planning coding projects and robotic functions. d. Write pseudocode that incorporates counted loops and subroutine structures to control program flow. e. Write pseudocode that incorporates decision making structures (e.g., IF, IF-THEN-ELSE) to control program flow. f. Write pseudocode that incorporates nested decision making structures. g. Use a flowchart, analogy, or visual programming environment to model the logical flow of a device.

Module 28A: Block-Based Coding A (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Explore programming concepts using a block-based language.	a. Differentiate between the functionality of visual or block-based (e.g., BlockyDuino, Scratch, Snap!, Ozoblockly, EdBlocks and JavaScript Blocks) and text-based (e.g., Python, C++, Java and JavaScript) programming languages. b. Explain some advantages and disadvantages of block-based programming languages. c. Create a program that uses one linear sequence of events in a block-based programming environment. d. Utilize an event to trigger a sequence of actions in a block-based programming environment. e. Adapt or create an unplugged program (i.e., not using a computer) that uses one linear sequence of events.

Module 28B: Block-Based Coding B (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: Module 28A**

Outcome	Indicators
Implement a program which utilizes control structures and repetition in a block-based coding environment.	a. Investigate repetition using block-based programming or unplugged activities. b. Investigate where a sequence repeats until an expected event occurs by using either block-based programming or unplugged activities. c. Create or adapt a program that makes a decision based on an input.

Module 29: Syntax and Organization (Optional)		
Suggested Time: 1-2 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Demonstrate proper syntax and organization when developing a program.	a. Explain the importance of following proper syntax practices for the programming language. b. Follow proper internal spacing practices for the programming language. c. Create internal documentation for programs. d. Ensure proper separation of different sections of the program (e.g., main program, subroutines and variables) to enhance readability.

Module 30A: Coding – Variables A (Core)		
Suggested Time: 1-3 hours	**Level: Introductory**	**Prerequisite: None**
Outcome	**Indicators**	
Explore the role of variables in programs.	a. Recognize that variables are placeholders for data, or containers used to hold information that can be later used in a program. b. Discuss the importance of following established conventions and rules for naming objects and variables within programming languages. c. Differentiate between variables and constants in a program. d. Explain the need to assign values to variables. e. Discuss the concept of scope (e.g., local and global) of variables within a program. f. Explore the importance of binary thinking (e.g., on versus off) in controlling devices. g. Provide examples of how to use arithmetic, comparison and Boolean operators to perform actions on variables. h. Demonstrate how to move or turn a sprite or robot by manipulating variables such as speed or direction.	

Module 30B: Coding – Variables B (Core)		
Suggested Time: 1-3 hours	**Level: Introductory**	**Prerequisite: Module 30A**
Outcome	**Indicators**	
Differentiate between common data types (e.g., integer, Boolean, floating point and string).	a. Identify the need for different data types in programming robotic and automated devices. b. Compare the characteristics of integer, Boolean, floating point, and string data types. c. Demonstrate how to convert variables of one data type to another data type and how that might impact the value of the variable. d. Discuss the importance of initializing variables in programs.	

Module 30C: Coding – Variables C (Optional)		
Suggested Time: 1-3 hours	**Level: Intermediate**	**Prerequisite: Module 30A**
Outcome	**Indicators**	
Explore the use of integer data types in programs.	a. Explain the advantages of using integer data types (e.g., int, short, long, byte) in a program. b. Explore the constraints of integer data types. c. Investigate the benefits and the challenges of carrying out mathematical calculations with integer data types. d. Demonstrate how to use an integer data type in a program.	

Module 30D: Coding - Variables D (Optional)		
Suggested Time: 1-3 hours	**Level: Intermediate**	**Prerequisite: Module 30A**

Outcome	Indicators
Incorporate Boolean and string data types in programs.	a. Explain why Boolean data types are used in programs. b. Provide examples of how Boolean data types can be used to control functions in a robotic or automated device. c. Write a program to set or change the state of a Boolean variable based on an input. d. Provide examples of how string data types (e.g., string, char and word) are used in programming robotic and automated devices. e. Explore the limitations of string data types. f. Write programs that utilize and manipulate string data types.

Module 30E: Coding – Variables E (Optional)		
Suggested Time: 2-5 hours	**Level: Intermediate**	**Prerequisite: Module 30A**

Outcome	Indicators
Investigate the use of floating point data types in programs.	a. Identify situations where it is beneficial to use floating point data types (e.g., float, double) in a program. b. Explore the constraints of floating point data types, including the challenges of carrying out mathematical calculations with floating point data types. c. Write programs that utilize and manipulate floating point data types.

Module 31A: Coding – Control Structures A (Optional)		
Suggested Time: 5-10 hours	**Level: Introductory**	**Prerequisite: Module 30A**

Outcome	Indicators
Create programs that use control structures to affect program flow.	a. Identify common control structures that affect program flow. b. Explain the primary function of a loop in a program and the role of conditions in controlling the number of iterations of the loop. c. Compare the characteristics of common looping structures (e.g., WHILE, DO-WHILE and FOR). d. Use looping structures to make a device repeat an action or series of actions a specific number of times or until a condition is met. e. Discuss the purpose of the BREAK, CONTINUE, GOTO, EXIT and SWITCH control structures.

Module 31B: Coding – Control Structures B (Optional)		
Suggested Time: 5-10 hours	**Level: Intermediate**	**Prerequisite: Module 31A**

Outcome	Indicators
Create programs that use conditional statements to control program flow.	a. Recognize that conditional statements represent decisions that are evaluated based on whether the condition evaluates to TRUE or FALSE. b. Provide examples of situations where conditional statements and nested conditional statements might be used in a program. c. Use conditional statements (e.g., IF, IF-ELSE, IF-THEN-ELSE and ELSE-IF) to have a device perform an action or differentiate between options. d. Use nested conditional statements to have a device make multiple consecutive decisions or differentiate between options. e. Use WAIT or DELAY to have a task WAIT for a conditional expression to be true or DELAY for a specified amount of time.

Module 32A: Coding - Functions A (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: Module 30A**

Outcome	Indicators
Create and incorporate functions in programs.	a. Investigate the purposes of functions (i.e., subroutines) in programs. b. Identify examples of common functions used in programming robots and automated devices. c. Explain how functions are called in programs. d. Recognize that functions can use local or global variables. e. Create functions that call local variables. f. Create functions that call global variables. g. Create a program that has more than one function utilizing identically named local variables.

Module 32B: Coding - Functions B (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: Module 32B**

Outcome	Indicators
Incorporate internal, external and user-defined libraries to extend the functionality of software.	a. Recognize that a library is a compilation of functions that can extend the functionality of software. b. Discuss why programming languages make use of libraries. c. Utilize internal libraries to reduce the required code necessary for a project. d. Import and incorporate an external library to solve a programming problem. e. Create a library to meet a specific need.

Module 32C: Coding - Functions C (Optional)		
Suggested Time: 3-5 hours	**Level: Advanced**	**Prerequisite: Module 31A, 32B**

Outcome	Indicators
Investigate how and when to incorporate recursive functions into programs.	a. Differentiate between the functionality of a loop (i.e., iteration) and a recursive function (i.e., recursion). b. Recognize that a recursive function is one that calls itself to solve a smaller instance of the same problem. c. Explain the importance of the terminating or base condition in a recursive function. d. Provide examples of situations where it is advantageous to use recursive functions in programming robotic and automated devices. e. Create a recursive function to solve a programming problem.

Module 33: Debugging Code (Optional)		
Suggested Time: 2-5 hours	**Level: Intermediate**	**Prerequisite: Module 30A**

Outcome	Indicators
Use common coding techniques to enhance code elegance and debug errors.	a. Discuss the concept of elegance in coding. b. Improve the elegance of existing code by simplifying, improving efficiency and enhancing code readability. c. Create internal documentation (e.g., inline comments and header comments) for a program. d. Discuss different types of errors (e.g., syntax, semantic and runtime) and their impacts on program execution. e. Discuss common steps for debugging code. f. Identify and correct errors in a program. g. Develop testing procedures, such as outputting values during execution, to debug programs.

Module 34A: Sensor Theory A (Optional)		
Suggested Time: 2-4 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Explore the use of sensors in robotic and automated devices.	a. Provide examples of everyday devices which use sensors. b. Explain the role of sensors in a robotic device. c. Identify how different categories of sensors, including tactile sensors and sensors for distance detection, motion detection, sound detection and heat detection, relate to the function of human sensory organs. d. Identify and use devices with a variety of sensors.

Module 34B: Sensor Theory B (Optional)		
Suggested Time: 2-3 hours	**Level: Advanced**	**Prerequisite: Module 34A**

Outcome	Indicators
Investigate how sensors interact with hardware and software in a device.	a. Discuss the characteristics of sensors. b. Explain how the output from a sensor can serve as an input to a program. c. Explain how sensors interact with the programming of a device. d. Investigate how the internal sensors of a robotic device may be used to measure the position, velocity and/or acceleration of the device or a portion of the device. e. Recognize that sensors can generate analog or digital signals.

Module 35A: Line Sensors A (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: Module 28A or 30A**

Outcome	Indicators
Construct and program a device capable of following a simple line.	a. Explain how a line follower sensor works. b. Attach and properly wire a line follower sensor to a device. c. Develop a program to debug a line follower sensor. d. Program a device to follow a straight line using input from a line follower sensor. e. Develop and implement a program to make a device follow a curved line using input from a line follower sensor. f. Describe practical applications of line follower robots.

Module 35B: Line Sensors B (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: Module 35A**

Outcome	Indicators
Construct and program a device capable of following a line that includes 90-degree turns and T-junctions.	a. Program a device to follow a line that includes left and right 90-degree turns using input from a line follower sensor. b. Program a device to follow a line that includes T-junctions using input from a line follower sensor. c. Program a device to make a decision (e.g., turn around, decide which way to turn or move in reverse) at a T-junction using input from a line follower sensor.

Module 35C: Line Sensors C (Optional)		
Suggested Time: 3-5 hours	**Level: Advanced**	**Prerequisite: Module 35B**

Outcome	**Indicators**
Construct and program a device capable of following a complex line, including dotted line sections.	a. Program a device to follow a complex solid line, including curves, 90-degree turns, greater than 90 degree turns and T-junctions using input from a line follower sensor. b. Program a device to make a decision at the end of a line using input from a line follower sensor. c. Program a device to follow a dotted line, including curves, 90-degree turns and T-junctions using input from a line follower sensor.

Module 36A: Tactile Sensors A (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: Module 28A or 30A**

Outcome	**Indicators**
Construct and program a device capable of using tactile sensors to make decisions.	a. Explain how a tactile sensor works. b. Attach and wire a tactile sensor properly to a device. c. Develop a program to debug a tactile sensor. d. Program a device to use input from a tactile sensor to make a decision which affects an output (e.g., light an LED, make a Beep or move a servo). e. Provide examples of how tactile sensing is used in robotics for manipulation, exploration and response.

Module 36B: Tactile Sensors B (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: Module 36A**

Outcome	**Indicators**
Construct and program a device capable of using multiple tactile sensors to make decisions.	a. Attach and properly wire at least two tactile sensors to a device. b. Program a device to use input from multiple tactile sensors to make a decision which affects an output (e.g., navigate around a room using tactile sensors). c. Differentiate between different types of tactile sensors, such as capacitive sensors, piezoresistive sensors, piezoelectric sensors, optical sensors, magnetics sensors and hydraulic sensors. d. Describe practical applications of tactile sensors in manufacturing, consumer devices, medical field and/or the automotive industry. e. Discuss challenges associated with making tactile sensing mimic human touch.

Module 37A: Ultrasonic Sensors A (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	Prerequisite: Module 28A or 30A

Outcome	**Indicators**
Construct and program a device that uses an ultrasonic sensor to detect distance.	a. Explain how an ultrasonic sensor works. b. Attach and wire an ultrasonic sensor properly to a device. c. Develop a program to debug an ultrasonic sensor. d. Program a device to detect the distance from an object using input from an ultrasonic sensor. e. Program a device to alter outputs (e.g., illuminate different LED lights for different distances or create a different beeping sequence or tone for different distances) based on distance from an object using input from an ultrasonic sensor. f. Provide practical examples of devices that incorporate ultrasonic sensors to detect distance from or to the sensor.

Module 37B: Ultrasonic Sensors B (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: Module 37A**

Outcome	**Indicators**
Construct and program a device that uses an ultrasonic sensor to navigate an area.	a. Program a device to navigate and avoid obstacles in an area using an ultrasonic sensor. b. Provide practical examples of devices that incorporate ultrasonic sensors to support device navigation. c. Program an ultrasonic sensor to measure the distance between the robotic device and an object and manipulate an output (e.g., change motor speed, change light colours or change speed of a beep). d. Design and develop a program capable of interpreting signals and making decisions based on the input from ultrasonic sensors. e. Manipulate the movement of a device based on proximity of an object to the device.

Module 37C: Ultrasonic Sensors C (Optional)		
Suggested Time: 3-5 hours	**Level: Advanced**	**Prerequisite: Module 37B**

Outcome	Indicators
Construct and program a device that uses multiple ultrasonic sensors to make decisions.	a. Program a device to make decisions (e.g., navigate a maze and stop when in a dead end or follow a wall around a room) using inputs from multiple ultrasonic sensors. b. Provide examples of how ultrasonic sensors are used in manufacturing environments to automate process control and maximize efficiency. c. Design and construct a device using multiple ultrasonic sensors to perform a task involving manipulating outputs (e.g., change movement based on inputs or alter direction of movement or reach out to touch an object). d. Evaluate the usefulness of an ultrasonic sensor in various situations.

Module 38A: Infrared Sensors A (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: Module 28A or 30A**

Outcome	Indicators
Construct and program a device that uses infrared lights and sensors to detect objects.	a. Explain how an infrared light and sensor works. b. Attach and properly wire an infrared light and sensor to a device. c. Develop a program to debut an infrared light and sensor. d. Program a device to detect an object in the vicinity of the device using input from infrared lights and sensors. e. Program a device to modify an output (e.g., light an LED, make a beep sound or move a servo) based on the presence of an object detected by infrared light and sensors .

Module 38B: Infrared Sensors B (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: Module 38A**

Outcome	Indicators
Construct and program a device capable of navigating around a room using infrared sensors.	a. Program a device to navigate and avoid obstacles in an area using input from infrared sensors. b. Provide examples of applications of infrared sensors. c. Design and develop a program capable of interpreting signals from and making decisions based on the input from infrared sensors. d. Manipulate the movement of a device based on proximity of an object to the device.

Module 38C: Infrared Sensors C (Optional)		
Suggested Time: 3-5 hours	**Level: Advanced**	**Prerequisite: Module 38B**

Outcome	Indicators
Construct and program a device that uses multiple infrared sensors to make decisions.	a. Program a device to make decisions (e.g., navigate a maze and stop when in a dead end or follow a wall around a room) using inputs from multiple infrared sensors. b. Design and construct a device using multiple infrared sensors to perform a task involving manipulating outputs (e.g., change movement based on inputs, alter direction of movement or reach out to touch an object). c. Evaluate the usefulness of an Infrared sensor in various situations.

Module 39A: Sound Sensors A (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: Module 28A or 30A**

Outcome	Indicators
Construct and program a device that can detect sound using a sound sensor.	a. Explain how a sound sensor works. b. Attach and properly wire a sound sensor to a device. c. Develop a program to debug a sound sensor. d. Develop and implement a program to detect sound in the vicinity of the device. e. Develop and implement a program to modify an output (e.g., light an LED, make a beep sound or move a servo) based on the detection of a sound.

Module 39B: Sound Sensors B (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: Module 39A**

Outcome	Indicators
Construct and program a device that can follow sound.	a. Program a device to follow sounds. b. Explain different ways in which a sound sensor could be used in a robotic device. c. Research non-robotic applications of sound sensors. d. Develop and construct a device to react (e.g., move away from a sound, wake up from a sound or change the colour of a light based on sound levels) to multiple different sounds.

Module 40A: Other Sensors A (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: Module 28A or 30A**
Outcome	**Indicators**	
Construct and program a device to detect an input from a sensor.	a. Design, construct and program a device to detect external temperature using input from a temperature sensor. b. Design, construct and program a device to detect and identify colour using input from a colour sensor. c. Design, construct and program a device to detect light using input from a light sensor (e.g., photoresistor). d. Design, construct and program a device to detect speed and/or acceleration using input from an accelerometer. e. Design, construct and program a device to detect differing angles using input from a gyroscope.	

Module 40B: Other Sensors B (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: Module 40A**
Outcome	**Indicators**	
Construct and program a device that uses a different sensor (not ultrasonic, infrared, sound, line following or tactile) to perform an associated task.	a. Design, construct and program a device to modify an output based on a temperature change. b. Design, construct and program a device to sort objects based on colour using input from a colour sensor. c. Design, construct and program a device to navigate towards/away from light using input from a light sensor (e.g., photoresistor). d. Design, construct and program a device to adjust a level using input from a gyroscope. e. Manipulate an output to signal detection using multiple sensors, for example sort objects based on colour.	

Module 41A: Wearable Technologies A (Optional)		
Suggested Time: 2-4 hours	**Level: Introductory**	**Prerequisite: None**
Outcome	**Indicators**	
Investigate the use of wearable technologies.	a. Research the development of wearable technologies, including e-textiles, activity trackers, fashion electronics, smart devices and products developed for electrostatic discharge control. b. Critique the functionality of wearable technologies, including issues related to data privacy. c. Examine the characteristics of conductive yarns that make them suitable for use in wearable technologies. d. Research costs associated with wearable technologies. e. Predict the role of wearable technologies in the future.	

Module 41B: Wearable Technologies B (Optional)		
Suggested Time: 5-10 hours	**Level: Intermediate**	**Prerequisite: Module 41A**

Outcome	Indicators
Construct and program a wearable device.	a. Design a device that uses wearable technologies. b. Recognize potential issues present in constructing a wearable device. c. Properly wire, attach, and program (if necessary) all components of a wearable device. d. Test the functionality of a wearable device.

Module 42: Radio-Frequency Identification (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: Module 28A or 30A**

Outcome	Indicators
Construct and program a device that uses radio-frequency identification (RFID) to accomplish a specific task.	a. Explain how RFID works. b. Attach and properly wire an RFID tag to a device. c. Develop a computer program to test the operation of a RFID tag (i.e., debug the sensor). d. Develop a program on a device that can modify an output based on input from an RFID tag. e. Research current applications of RFID such as asset management; tracking of goods, people, or animals; timing sports events and passport control. f. Discuss potential future applications of RFID. g. Research concerns, controversies and ethical considerations related to the use of RFID.

Module 43A: Transmitting and Receiving A (Optional)		
Suggested Time: 2-4 hours	**Introductory**	**Prerequisite: None**

Outcome	Indicators
Connect transmitting and receiving devices.	a. Use terms (e.g., binding, pairing, tethered and wireless) associated with making connections between transmitters and receivers correctly. b. Identify properties of transmitting and receiving devices such as distance, number of channels, current and antenna length. c. Practice binding and/or pairing transmitting and receiving devices such as connecting a speaker to a smartphone using Bluetooth.

Module 43B: Transmitting and Receiving B (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: Module 43A**

Outcome	Indicators
Control a robotic or automated device using transmitting and receiving devices.	a. Research the use of remote control devices (e.g., bed in hospital, pump truck and crane) in society. b. Recognize that an additional antenna or antenna length can extend the distance of a radio signal. c. Investigate a variety of ways in which devices can be "bound" or "paired" (e.g., laptop to microprocessor, gamepad controller to microprocessor and cell phone to robot through Bluetooth). d. Plan and implement a challenge which incorporates a transmitting and receiving device. e. Design and construct a robotic or automated device which requires a transmitter and receiver for control.

Module 43C: Transmitting and Receiving C (Optional)		
Suggested Time: 3-5 hours	**Level: Advanced**	**Prerequisite: Module 43B**

Outcome	Indicators
Customize a transmitter for control of a robotic or automated device.	a. Develop an understanding of the mapping of a transmitter (i.e., channel controls and trims). b. Demonstrate control of multiple outputs (e.g., servos, motors, actuators and pneumatic devices) from a single transmitter. c. Program a transmitter (e.g., reversing channels, speed controls, setting limits and naming) to control a specific robotic or automated device.

Module 44A: Power Sources A (Optional)		
Suggested Time: 2-4 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Examine a variety of power sources suitable for robotic and automation applications.	a. List and describe the advantages and disadvantages of different types of power sources (e.g., wall outlet, lab power supply, battery, solar and alternative) and their suitability for robotics and automation applications. b. Compare different power sources in terms of power supply, current supply, power reliability and functionality. c. Examine the difference between alternating current (AC) and direct current (DC) power sources and their suitability for robotics and automation applications. d. Determine the suitability of various power sources for use in a robotics or automation application. e. Select a power source for use in a robotics or automation application.

Module 44B: Power Sources B (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: Module 44A**

Outcome	Indicators
Analyze different types of batteries for their suitability in robotics and automation applications.	a. Determine the output voltage of batteries connected in parallel and in series. b. Describe the differences between types (e.g., lithium, nickel cadmium, alkaline and acid) of batteries. c. Identify the advantages and disadvantages of various types of batteries, considering factors such as power, weight, current discharge/charge rate, size, longevity of charge and cost. d. Practise safe work procedures when assembling batteries in parallel or series. e. Practise safe work procedures, such as using appropriate testers and tools and observing proper electrical safety practices, when testing batteries. f. Practise proper battery charging techniques, including using proper chargers, appropriate amperage and voltage, proper spacing and proper connections to charging source. g. Select an appropriate battery type and configuration for a robotics or automation project. h. Dispose of batteries appropriately and with consideration for environmental concerns.

Module 45: Drive Systems (Optional)		
Suggested Time: 3-8 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Evaluate drive systems for suitability in robotics and automation applications.	a. Identify different drive systems (e.g., direct drive chain/sprocket, belt/pulley, biped, 2-wheel drive, 4-wheel drive, front wheel drive, rear wheel drive, all-wheel drive, track drive and walking) for robotics and automation applications. b. Compare the attributes of different drive systems to achieve various needs. c. Identify the appropriate drive system to meet a specific need. d. Evaluate a chosen drive system for suitability in a specific device.

Module 46: Wheels (Optional)		
Suggested Time: 2-4 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Evaluate wheels for suitability in robotics and automation applications.	a. Identify possible materials (e.g., foam, rubber, plastic and polyurethane) that can be used to construct wheels for robotic and automation applications. b. Evaluate the use of different materials for a specific application of a wheel. c. Identify the characteristics of different types of wheels (e.g., fixed, treaded, smooth, air tube, ball, Omni, Mecanum and solid) for robotic and automation applications. d. Critique the use of different types of wheels for the functionality and purpose of a specific robotic or automation application. e. Evaluate a chosen wheel for use in a specific robotic or automation application.

Module 47: Gears (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: None**

Outcome	Indicators
Evaluate the suitability of gears, sprockets and chains and pulleys and belts for robotics and automation applications.	a. Explain the purpose of gears, sprockets and chains and pulleys and belts in robotics and automation applications. b. Examine how gears can be used to change the direction of rotation of a drive shaft. c. Compare the suitability of different types (e.g., flat, round, Vee, and toothed) of belts for various robotics and automation applications. d. Calculate gear ratios using the following formulas: • gear ratio = # of driven gear teeth/# driving gear teeth • gear ratio = diameter of driven pulley/diameter of the driving pulley e. Calculate torque and speed changes using the following formulas: • output torque = input torque x gear ratio • output speed = input speed/gear ratio f. Convert angular speed of a drive shaft (e.g., rpm) to linear speed (e.g., cm/s) using the formulas: • revolutions per second (rps) = revolutions per minute (rpm) x 60 • Angular speed (radians per second) = 2 x pi x rps • Linear speed = radius of wheel x angular speed g. Describe some of the challenges associated with using pulleys and belts, gears, or chains in robotic and automation applications.

Module 48: Motors (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Experiment with the properties and capabilities of direct current (DC) motors.	a. Identify the components (e.g., shaft, commutator, brushes, case, leads, core and coils) of a brushed motor. b. Build a DC motor using materials such as a battery, magnet, paper clips and enameled wire. c. Evaluate the operation of a self-made direct-current (DC) motor. d. Explain the role of magnetism and electromagnetism in the operation of DC motors. e. Provide examples of how DC motors are used in robotics and automation applications. f. Build a testbed to test whether motors and servos work properly prior to device assembly.

Module 49: Servos (Optional)		
Suggested Time: 3-5 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Investigate applications of servos in robotics and automation applications.	a. Differentiate between servos and motors. b. Recognize what type of signal controls a servo. c. Attach and properly wire a servo to a device. d. Compare the operation and function of continuous and positional rotation servos. e. Determine the suitability of a servo for a specific application, considering factors such as type, physical size and speed. f. Calibrate positional rotation servos. g. Build a testbed to test whether motors and servos work properly prior to device assembly. h. Construct a device that incorporates a standard servo. i. Construct a device that incorporates a continuous rotation servo.

Module 50: Stepper Motors (Optional)		
Suggested Time:3-5	**Level: Advanced**	**Prerequisite: None**

Outcome	Indicators
Explore applications of stepper motors in robotics and automation applications.	a. Explain the operation of a stepper motor. b. Explain when it is appropriate to use a stepper motor rather than a servo. c. Describe the relationship between voltage level, speed and torque in a stepper motor. d. Explain how stepper motors are rated. e. Explore common applications of stepper motors.

Module 51A: Actuators A (Optional)			
Suggested Time: 2-4 hours		**Level: Intermediate**	**Prerequisite: Module 44, 49**
Outcome	**Indicators**		
Experiment with the properties and capabilities of actuators.	a. Describe the purpose and function of an actuator. b. Differentiate between the characteristics of different types of actuators (e.g., DC brushed and brushless motors, linear actuators, solenoids, electromagnets and servos). c. Match types of actuators with specific tasks (e.g., DC motor to drive and linear actuator to move arm). d. Investigate how limit switches and diodes are used to restrict actuator motion.		

Module 51B: Actuators B (Optional)			
Suggested Time: 5-10 hours		**Level: Intermediate**	**Prerequisite: Module 51A**
Outcome	**Indicators**		
Design and construct a device that incorporates an actuator.	a. Examine actuators and their ratings (e.g., voltage, current, torque, length, size, bolt patterns and mass) for use in specific situations. b. Choose an appropriate actuator to meet a specific requirement. c. Mount actuators to a device appropriately to maximize efficiency. d. Evaluate the efficiency of an actuator selected for a specific task.		

Module 52A: Motor Controllers A (Optional)			
Suggested Time: 2-4 hours		**Level: Introductory**	**Prerequisite: None**
Outcome	**Indicators**		
Use motor controllers to power motors.	a. Describe the role of a motor controller in robotics and automation applications. b. Choose the correct motor controller for a stated motor size and type, considering factors such as current, voltage, number of motors and brushed versus brushless design. c. Arrange the correct DIP switch or jumper wire orientation on a motor controller for desired usage. d. Wire a motor controller to a receiver and to one or more motors.		

Module 52B: Motor Controllers B (Optional)		
Suggested Time: 2-4 hours	**Level: Intermediate**	**Prerequisite: Module 52A**

Outcome	Indicators
Assess the use of different motor controllers with specific motor types.	a. Differentiate between an electronic speed control (ESC) and a motor controller. b. Research and evaluate motor controller types for appropriate usage based on functionality and features. c. Summarize the functionality (e.g., radio controlled, analog and pulse width modulation) of a specific motor controller. d. Discuss the function of the battery eliminator circuit (BEC) on some motor controllers. e. Construct a circuit that utilizes a motor controller and appropriate motor.

Module 53A: Drones A (Optional)		
Suggested Time: 4-5 hours	**Level: Intermediate**	**Prerequisite: None**

Outcome	Indicators
Research and follow requirements for operating drones in Canada.	a. Research legislation related to operating drones in Canada. b. Understand the difference between basic and advanced drone operations in Canada. c. Display a knowledge of safe drone flying practices. d. Obtain appropriate pilot certification before operating a drone. e. Ensure drones are properly registered with Transport Canada.
Note	All safety regulations and pilot certification must be done in accordance with Transport Canada regulations.

Module 53B: Drones B (Optional)		
Suggested Time: 5-7 hours	**Level: Intermediate**	**Prerequisite: Module 53A**

Outcome	Indicators
Experiment with the movement and workings of a drone.	a. Explain the advantages and disadvantages of drone technology. b. Review ethics and local laws pertaining to drone usage. c. Provide examples of civil, commercial and military applications of drones. d. Use a simulator program to practice drone control and flight. e. Perform basic maneuvers with a drone, such as guiding it through a simple course.

Module 53C: Drones C (Optional)		
Suggested Time: 5-10 hours	**Level: Advanced**	**Prerequisite: Module 43B, 51B, 52A, 53A**

Outcome	Indicators
Design, construct and safely control a drone.	a. Create a scale drawing of a drone project using appropriate symbols. b. Calculate the cost of materials to construct a drone. c. Develop and carry out a project plan to construct a drone, including major stages of development and a timeline needed for completion. d. Demonstrate advanced electrical wiring and building skills through improved wire management, proper component usage and improved building and material efficiency, when constructing a drone. e. Demonstrate drone control and flight with appropriate use of throttle, roll, pitch and yaw controls.

Module 54: Machine Safety (Optional)		
Suggested Time: 1-2 hours	**Level: Intermediate**	**Prerequisite: Module 1**

Outcome	Indicators
Demonstrate safe practices when working with properly maintained mechanical equipment.	a. Explain the purpose of ventilation in a confined environment when working with mechanical equipment (e.g., grinders, solder pencils, saws and welding equipment). b. Compile information on the safe use, care and maintenance of mechanical equipment (e.g., drills, grinders, saws, solder pencils and welding equipment). c. Analyze shop and workplace situations to identify hazards and seek solutions. d. Describe safety precautions including the use of personal protective equipment (PPE) required for each tool used. e. Use mechanical equipment safely.
	Note: Safety must be the primary focus for students each day.

Module 55: Properties of Materials (Optional)		
Suggested Time: 2-3 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Analyze the properties of materials and experiment with their uses in robotics and automation applications.	a. Compare the properties (e.g., mass, pliability, strength, elasticity, durability and memory of the material) of various materials (e.g., plastic, wood and metal) that might be used in robotics and automation applications. b. Choose appropriate materials (e.g., plastic, wood and metal) for robotics and automation applications. c. Demonstrate the use of various materials (e.g., plastic, wood and metal) in a specific application.

Module 56: Fasteners (Optional)		
Suggested Time: 1-2 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Use fasteners and adhesives effectively in robotics and automation applications.	a. Determine the characteristics of various types of nails, screws and bolts. b. Select the best fasteners for a given task based on their characteristics. c. Identify common glues and mastics to determine the appropriate product for a specific application. d. Investigate the use of spot welding and riveting to determine which would be best for a given task.

Module 57: Mechanical Structure (Core)		
Suggested Time: 3-6 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Investigate techniques used to build mechanical structure for use in robotics and automation applications.	a. Investigate the stability of various types of connections. b. Explore the suitability of various supports for overhanging structures and for mobile structures. c. Critique the suitability of different structures for their ability to provide support and stability. d. Construct stable and sturdy bases, including bases for moving parts, for robotics and automation applications. e. Ensure proper fit and alignment of constructed components.

Module 58A: Fabricate A (Optional)		
Suggested Time: 2-3 hours	**Level: Introductory**	Prerequisite: None

Outcome	**Indicators**
Modify existing parts for use in a device.	a. Develop a plan to modify a pre-existing part for suitable use on a device. b. Modify a pre-existing part appropriately for suitable use on a device (e.g., take an arm off of a mannequin and attach a motor to it to use in a project). c. Install and use a modified part on a device.

Module 58B: Fabricate B (Optional)		
Suggested Time: 2-3 hours	**Level: Intermediate**	**Prerequisite: Module 58A**

Outcome	**Indicators**
Design and create a single part for use in a device.	a. Design a single part to be used with a device. b. Create a single part for a device using 3D printing, computer numerical control manufacturing or construction out of wood or other materials. c. Incorporate a single part in a device.

Module 58C: Fabricate C (Optional)		
Suggested Time: 3-5 hours	**Level: Advanced**	**Prerequisite: Module 58B**

Outcome	**Indicators**
Design and build a multi-part device.	a. Design a multi-part device to accomplish a specific task. b. Create the parts for a personally-designed multi-part device using 3D printing, computer numerical control manufacturing or construction out of wood or other materials. c. Construct a personally-designed multi-part device.

Module 59: 3D CAD Basics (Optional)		
Suggested Time: 3-8 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Create representations of 3-dimensional (3D) objects using computer-aided design (CAD) software.	a. Draw basic elements (e.g. sphere, box, pyramid and prism) to specific dimensions using CAD software. b. Use basic commands (e.g., extrusion, circles and revolutions) in CAD software. c. Create a composite 3D object to specific dimensions through the merging and subtraction of component objects. d. Design a 3D model of an item, using CAD or modeling software, for the purpose of modelling a usable component for a robotics or automation application.

Module 60A: 3D Printing A (Optional)		
Suggested Time: 5-10 hours	**Level: Intermediate**	**Prerequisite: Module 59**

Outcome	Indicators
Construct an object using a 3-dimensional (3D) printing process.	a. Distinguish between positive and negative space in plans for 3D objects. b. Understand the concept of melted material or liquid/laser material being placed according to computer instructions or code. c. Understand basic design restrictions and limitations (e.g., raft, overhang, support material, infill and density) associated with 3D printing. d. Follow a plan to create a simple 3D object, using 3D CAD or modeling software, that includes: ○ a simple slab or a block; ○ holes in the slab or block; and, ○ protrusions or cuts on the slab or block. e. Prepare the 3D design for printing using a 3D printer.

Module 60B: 3D Printing B (Optional)		
Suggested Time: 5-10 hours	**Level: Intermediate**	**Prerequisite: Module 60A**

Outcome	Indicators
Design a 3D printed object to solve a problem encountered in robotics and automation applications.	a. Develop a prototype of a solution to a problem using a variety of materials (e.g., plasticine, cardboard, tape and wire). b. Utilize 3D design or modeling software to create a digital representation of a prototyped solution. c. Create an object using a 3D printer and test it as a solution to a problem.

Module 61A: CNC Manufacturing A (Optional)		
Suggested Time: 5-10 hours	**Level: Intermediate**	**Prerequisite: Module 59**

Outcome	Indicators
Construct two-dimensional (2D) objects using computer numerical control (CNC) manufacturing.	a. Design 2D objects using computer-aided design (CAD) software to be manufactured using a CNC machine. b. Recognize the strength and limitations of manufacturing 2D objects using CNC. c. Manufacture 2D objects using a CNC machine.

Module 61B: CNC Manufacturing B (Optional)		
Suggested Time: 5-10 hours	**Level: Advanced**	**Prerequisite: Module 61A**

Outcome	Indicators
Construct three-dimensional (3D) objects using computer numerical control (CNC) manufacturing.	a. Design 3D objects using computer-aided design (CAD) or modeling software to be manufactured using a CNC machine. b. Recognize the strength and limitations of manufacturing 3D objects using CNC. c. Manufacture 3D objects using a CNC machine.

Module 62A: Fluid Power A (Optional)		
Suggested Time: 1-2 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Construct a mechanical device that incorporates principles of fluid power systems.	a. Describe how hydraulic or pneumatic pressure can be used to create a mechanical advantage in a simple mechanical device such as a hydraulic lift or pneumatic arm. b. Design, construct, and evaluate a prototype of a device that models the operation of a fluid power system. c. Identify the advantages and disadvantages (e.g., strength, speed, fluid supply and leaks) of a fluid power system. d. Identify common applications (e.g. braking systems, lifting systems and launching systems) of fluid power systems.

Module 62B: Fluid Power B (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate**	**Prerequisite: Module 62A**

Outcome	Indicators
Design and build hydraulic and/or pneumatic components or systems.	a. Draw schematic diagrams of hydraulic and/or pneumatic circuits. b. Describe how a positive displacement compressor works. c. Illustrate how pressure can be controlled in a device using hydraulics or pneumatics. d. Describe the different types of control valves on pneumatic components. e. Explain the importance of the safety relief valve on a pneumatic component. f. Identify common types (e.g., flanged, tie rod, threaded end, one-piece welded, single-acting, double-acting and telescoping) of pneumatic cylinders and how they might be used in robotics and automation applications. g. Construct a hydraulic and/or pneumatic component (e.g., pneumatic arm, hydraulic lifter, pneumatic clamp and propulsion system) for a mechanical purpose.

Module 63A: Automation A (Optional)		
Suggested Time: 10-15 hours	**Level: Intermediate**	**Prerequisite: None**

Outcome	Indicators
Construct a simple automated device.	a. Design a device to automatically perform a task using a single sensor (e.g., tactile, infrared and ultrasonic). b. Construct a simple automated device using available materials. c. Troubleshoot the functioning of a simple automated device. d. Analyze the functionality and ease of use of a simple automated device.

Module 63B: Automation B (Optional)		
Suggested Time: 10-20 hours	**Level: Intermediate**	**Prerequisite: Module 63A**

Outcome	Indicators
Construct an intermediate automated device.	a. Design a device to automatically perform a task using multiple sensors (e.g., tactile, infrared and ultrasonic) or perform a multi-step task using a single sensor. b. Construct an intermediate automated device using available materials. c. Troubleshoot the functioning of an intermediate automated device. d. Analyze the functionality and ease of use of an intermediate automated device.

Module 63C: Automation C (Optional)		
Suggested Time: 10-20 hours	**Level: Advanced**	**Prerequisite: Module 63B**

Outcome	Indicators
Construct a complex automated device.	a. Design a device to automatically perform a multi-step task using multiple sensors (e.g., tactile, infrared sensor and ultrasonic). b. Construct a complex automated device using available materials. c. Troubleshoot the functioning of a complex automated device. d. Analyze the functionality and ease of use of a complex automated device.

Module 64: Machine Vision (Optional)		
Suggested Time: 5-10 hours	**Level: Advanced**	**Prerequisite: None**

Outcome	Indicators
Investigate the use of machine vision in robotics and automation applications.	a. Explain the processes and technologies associated with machine vision. b. Differentiate between machine vision, computer vision, machine learning and artificial intelligence. c. Research how machine vision can be used in robotics and automation applications. d. Develop a machine vision solution to a problem such as a coin counter, product label inspector, auto-pan camera and robot guidance.

Module 65: Physical Space Management (Optional)		
Suggested Time: 1-2 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Evaluate workspace organization for effectiveness and efficiency.	a. Choose an appropriate workspace for a given task. b. Maintain organization of tools and materials to prevent loss or damage. c. Maintain a safe workspace environment. d. Demonstrate consideration for other users of a shared space.

Module 66A: Project Management A (Optional)		
Suggested Time: 1-2 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Create, follow and manage a basic project plan.	a. Apply a basic project design including: ● identifying the tasks necessary to complete a simple project; ● assigning an approximate length of time to each task in a project; and, ● generating a timeline for task completion. b. Monitor and adjust project timeline as needed. c. Reflect on project plan at completion.

Module 66B: Project Management B (Optional)		
Suggested Time: 1-2 hours	**Level: Intermediate**	**Prerequisite: Module 66A**

Outcome	Indicators
Create, follow and manage a multi-step project plan.	a. Apply a detailed project design including: ● identifying the tasks necessary to complete a multi-step project; ● assigning an approximate length of time to each task in a project; and, ● generating a timeline for task completion. b. Monitor and adjust project timeline in response to changing circumstances. c. Reflect on a completed project plan and summarize suggestions for improving a future project plan.

Module 66C: Project Management C (Optional)		
Suggested Time: 3-5 hours	**Level: Advanced**	**Prerequisite: Module 66B**

Outcome	Indicators
Design, implement and manage a detailed project plan that utilizes team member strengths and interests.	a. Discuss group processes that affect team effectiveness. b. Evaluate skills and interests of team members, including self. c. Apply a detailed project design including: ● identifying the tasks necessary in completing a large project; ● assigning tasks to team members that takes advantage of their skills and interests; and, ● generating a timeline for task completion. d. Monitor and adjust project timeline and task assignments in response to changing circumstances. e. Self-assess one's contribution to group projects.

Module 67A: Introductory Project (Optional)		
Suggested Time: 10-20 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Construct an introductory level assigned or approved robotics or automation project.	a. Construct an introductory level project following guidelines such as: • generate different project ideas; • plan and manage the project including assessment criteria in consultation with the instructor; • plan and use diagrams to guide construction; • set a procedural sequence; • create a timeline; • determine fabrication techniques; • identify, acquire, and use the appropriate materials and parts; • interpret and follow directions; • adhere to timelines; • work cooperatively; • follow all safety requirements; • follow all handling and storing procedures; • fulfill cleanup and tool maintenance responsibilities; and, • present the completed project and complete a self-assessment based on the criteria for the project.

Module 67B: Intermediate Project (Optional)		
Suggested Time: 10-20 hours	**Level: Intermediate**	**Prerequisite: Module 67A**

Outcome	Indicators
Construct an intermediate level assigned or approved robotics or automation project.	a. Assemble and present a project utilizing skills in planning and management as outlined in Module 67A: Introductory Project. b. Demonstrate increasingly proficient fabrication techniques, work skills, and presentation skills.

Module 67C: Advanced Project (Optional)		
Suggested Time: 30-50 hours	**Level: Advanced**	**Prerequisite: Module 67B**

Outcome	Indicators
Construct an advanced level assigned or approved robotics or automation project.	a. Assemble and present a project utilizing skills in planning and management as outlined in Module 67A: Introductory Project. b. Demonstrate increasingly proficient fabrication techniques, work skills, and presentation skills.

Module 68A: Careers in Robotics and Automation A (Core)		
Suggested Time: 3-4 hours	**Level: Introductory**	**Prerequisite: None**

Outcome	Indicators
Explore robotics and automation career paths in Saskatchewan, Canada and the world.	a. Research career options and trends in robotics and automation in Saskatchewan, Canada and the world. b. Develop a list of career opportunities related to the fields of robotics and automation. c. Communicate research findings related to occupations in robotics and automation through a display, brochure, video, presentation software, website or oral presentation.

Module 68B: Careers in Robotics and Automation B (Core)		
Suggested Time: 3-4 hours	**Level: Intermediate**	**Prerequisite: Module 68A**

Outcome	Indicators
Examine the skills necessary to pursue robotics and/or automation related career paths.	a. Research the education requirements of various career paths and identify those that align with personal lifestyle goals. b. Identify and report on opportunities for experiential learning (e.g., co-op programs, job shadowing and career fairs) in the field of robotics and automation. c. Research and report on post-secondary educational programs leading to careers in robotics and automation, considering factors such as institutions offering relevant programs, industry certifications, courses of study, entrance requirements, length of programs and costs. d. Inquire into issues of gender equity and diversity in the robotics and automation workplace, considering questions such as "Who is typically underrepresented in the robotics and automation field and why?" and "What steps could be taken to encourage people from under-represented groups to pursue robotics and automation related careers?"

Module 68C: Careers in Robotics and Automation C (Core)		
Suggested Time: 3-4 hours	**Level: Advanced**	**Prerequisite: Module 68B**

Outcome	Indicators
Research robotics related career paths in Saskatchewan, Canada, and the world.	a. Visit local businesses and organizations that use or make robotics, such as health care robots, agriculture robots or robot chefs. b. Visit post-secondary institutions (e.g., University of Saskatchewan, University of Regina and Saskatchewan Polytechnic) that offer courses related to robotics and automation. c. Develop a profile of a specific individual involved in a robotics-related career, addressing factors such as their educational and personal background, what drew them to their career, the focus of their work and their advice for others who wish to pursue a similar career. d. Participate in a career fair and analyze robotics related career choices based on information gathered. e. Participate in a workplace-based career development opportunity (e.g., job shadow and career spotlight) related to robotics and automation.

Module 69A & B: Work Study Preparation (Optional)		
Suggested Time: 3-5 hours	**Level: Intermediate/Advanced**	**Prerequisite: None**
Note: Work Study is used to prepare students for employment through specific skill development within a workplace. The number of work study opportunities is equal to the number of courses available in the curriculum area at the 20 and 30 level.		

Outcome	Indicators
Prepare for the work placement.	a. Explain the roles and responsibilities of each partner (e.g., student, parent, teacher or other school staff, employer) involved in the work placement. b. Research the business/organization to become familiar with its operations. c. In collaboration with all partners, develop personal and learning goals for the work placement. d. Develop a procedural guide for the work placement that includes items such as: • transportation to and from the work placement; • hours of work; • guidelines for absence and tardiness; • dress code; • job description; and, • conflict resolution e. Compile an employer information package that includes documents needed for the work placement (e.g., personal career documentation such as a resume or portfolio, permission forms, logs, self- and employer evaluation forms). f. Brainstorm a list of questions to ask the employer before beginning the work placement; these may include: • What is my schedule of work hours? • Who is my supervisor? • What should I wear? • When will I be provided with safety training? • What potential hazards might I encounter in the work placement? • Where do I find fire extinguishers, first aid kits and emergency assistance? • What type of safety gear am I expected to wear? Is it provided? • What should I do if I get injured or have an accident in the workplace? • How can I contact my health and safety committee or representative? • Are there any health and safety procedures I should follow? • Who is the first aid person? • Where are safety notices posted? • What should I do in case of a fire or emergency? g. Develop a list of questions that could potentially be asked by the employer/work placement in an interview situation as well as answers to the questions.

	h. Participate in an interview with the employer prior to beginning the work placement. i. Reflect upon one's performance during the interview.
Note: For more information about implementing work study in schools, see the Work Study Guidelines for the Practical and Applied Arts included in the *Practical and Applied Arts Handbook*.	

Module 70A & B: Work Study Placement (Optional)		
Suggested Time: 25-50 hours	**Level: Intermediate/Advanced**	**Prerequisite: Module 69A & B**
Outcome	**Indicators**	
Participate in a work placement experience.	a. Apply relevant skills and abilities during the work placement experience. b. Document one's experience using electronic and other tools (e.g., vlogs, blogs, log sheets, reflective journals) to summarize and reflect upon items such as: • hours of work including breaks; • responsibilities and tasks performed; • interactions with the employer, staff, customers and others; • company or organization's 'raison d'être;' and, • skills developed and demonstrated during the work placement that enhance one's employability. c. Document knowledge and awareness of labour standards, safety, workplace ethics, rights and responsibilities, occupational health and safety, and networking observed during the work placement.	
Note: For more information about implementing work study in schools, see the Work Study Guidelines for the Practical and Applied Arts included in the *Practical and Applied Arts Handbook*.		

Module 71A & B: Work Study Follow-up (Optional)		
Suggested Time: 2-4 hours	**Level: Intermediate/Advanced**	**Prerequisite: Module 70A**

Outcome	**Indicators**
Relate one's work placement experience to personal and career goals.	a. Showcase one's skills and abilities demonstrated during the work placement using artifacts, evidence of skill development and personal reflections on aspects of the work experience such as: • hours worked; • responsibilities and tasks performed; • the importance of attitude towards work and taking responsibility for what needs to be done; • details about the entry level wage, salary scales and earning potential; • worker rights and responsibilities and the role of the union, if applicable; • ownership structure (e.g., corporation, franchise, sole proprietorship, partnership); and, • opportunities for advancement at the workplace and elsewhere in the industry. b. Reflect on the attainment of personal and learning goals. c. Update personal career documentation (e.g., resume, portfolio) following the work placement. d. In appreciation prepare a letter, note, card or other communication for the work placement employer. • Develop and/or revise personal and career goals based on the work placement experience.

Module 99A, B & C: Extended Study		
Suggested Time: 10-25 hours	**Level: Introductory/ Intermediate/Advanced**	**Prerequisite: None**

Note: The extended study module may be used only once in each 100-hour course.

Module Overview: Evolving societal and personal needs, advances in technology, and demands to solve current problems require a flexible curriculum that can accommodate new ways and means to support learning in the future. The extended study module is designed to provide schools and teachers with an opportunity to meet current and future demands not provided for in current modules of the PAA curriculum. This flexibility allows a school or teacher to design one new module per credit to complement or extend the study of the core and optional modules to meet the specific needs of students or the community. The extended study module is designed to extend the content of the pure courses and to offer survey course modules beyond the scope of the available selection of PAA modules, either in depth or breadth. The list of possibilities for topics of study or projects for the extended study module approach is as varied as the imagination of those involved in using the module. The extended study module guidelines should be used to strengthen the knowledge, skills, and processes advocated in the PAA curriculum. For more information on the guidelines for the Extended Study module, see the *Practical and Applied Arts Handbook.*

Assessment and Evaluation of Student Learning

Assessment and evaluation are continuous activities that are planned for and derived from curriculum outcomes and consistent with the instructional learning strategies. The depth and breadth of each outcome, as defined by the indicators, informs teachers of the skills, processes and understandings that should be assessed.

Assessment is the act of gathering information on an ongoing basis in order to understand individual students' learning and needs.

Evaluation is the culminating act of interpreting the information gathered through relevant and appropriate assessments for the purpose of making decisions or judgements, often at reporting times.

Effective and authentic assessment and evaluation involves:

- designing performance tasks that align with curricular outcomes;
- involving students in determining how their learning will be demonstrated; and,
- planning for the three phases of assessment and evaluation indicated below.

Formative Assessment		**Summative Assessment and Evaluation**
Assessment *for* Learning involves the use of information about student progress to support and improve student learning, inform instructional practices, and: • is teacher-driven for student, teacher and parent use; • occurs throughout the teaching and learning process, using a variety of tools; and, • engages teachers in providing differentiated instruction, feedback to students to enhance their learning and information to parents in support of learning.	**Assessment *as* Learning** involves student reflection on learning, monitoring of own progress, and: • supports students in critically analyzing learning related to curricular outcomes; • is student-driven with teacher guidance; and, • occurs throughout the learning process.	**Assessment *of* Learning** involves teachers' use of evidence of student learning to make judgements about student achievement and: • provides opportunity to report evidence of achievement related to curricular outcomes; • occurs at the end of a learning cycle, using a variety of tools; and, • provides the foundation for discussions on placement or promotion.

There is a close relationship among outcomes, instructional approaches, learning activities, assessment and evaluation. Assessments need to be reflective of the cognitive processes and level(s) of knowledge indicated by the outcome. An authentic assessment will only collect data at the level for which it is designed.

Glossary

Abstraction is the process of identifying general principles in order that one solution can solve multiple problems.

An **AC motor** is an electric motor that is driven by alternating current (AC).

An **actuator** is a component of a machine that is responsible for moving and controlling a mechanism or system, for example by opening a valve.

An **algorithm** is a series of systematic instructions to solve a problem.

Alternating current (AC) is electric current which periodically reverses direction of current flow.

An **analog signal** is any continuous signal that can vary in value and can have an infinite number of values. (e.g., anywhere from 0 volts to 5 volts).

An **analog device** is any device such as a sensor that will produce an output with an infinite number of values over a given range.

Arithmetic operators such as addition (+), subtraction (-), division (/) and multiplication (*) are used to manipulate numerical values.

Automation is using computer software or technology to carry out a task with minimal human assistance.

An autonomous device is a device that is able to gather data from its environment through sensors and respond based on that data.

A **battery eliminator circuit (BEC)** is an electronic circuit designed to deliver electrical power to other circuitry without the need for multiple batteries.

Binding is the act of wirelessly connecting an RC transmitter and receiver together.

Block-based coding is coding within a programming language where instructions are mainly represented as blocks.

Boolean is a data type referring to two possible values called “true” and “false.”

Bound (paired) - see Binding.

A **breadboard** is a solderless device for prototyping electronics and testing circuit designs.

A **channel** is a controllable function of a radio controlled device.

A **compiler** is a program that converts computer code written in one programming language into another programming language that a computer can read and execute.

Computer numerical control (CNC) is the automated control of machining tools by a computer. There are 2D (fixed depth control) and 3D (varying depth controls) versions of this.

Computational thinking is the thought process involved in describing a problem and its solutions so that an information-processing agent can carry out the solution. The defining characteristics of computational thinking are decomposition, pattern recognition, data representation, abstraction and algorithms.

A c**onditional statement** is a feature of a programming language that will complete some calculation or action and return a value of true or false.

Current is the rate at which charged particles flow past a point and is measured in Amperes (A).

A **DC motor** is an electric motor that is driven by direct current (DC).

Debugging is the process of finding and resolving defects or problems within a computer program.

Decomposition is breaking a complex problem into simpler parts.

A **digital device** is any device such as sensor that will produce an output with one of two values.

A **diode** is a two-terminal electronic component that conducts current primarily in one direction.

A **DIP switch** is a manual electric switch that is packaged with others in a dual-in-line package.

Direct current (DC) is electric current which only flows in one direction.

A **drone**, or unmanned aerial vehicle, is an aircraft without a human pilot aboard.

An **electronic speed controller (ESC)** is an electronic circuit that controls and regulates the speed of an electric motor.

A **floating point** data type, also called float or real, represents a limited precision rational number that may have a fractional part.

A **function**, or subroutine, is a sequence of program instruction that perform a specific task, packaged as a unit that can be called from a program.

Hydraulic refers to the mechanical properties and uses of liquids.

Input is information supplied to a computer program or device.

An **infrared sensor** is an electronic sensor that detects infrared radiation.

Integer is a data type refers to numeric data consisting of whole numbers.

An **integrated development environment (IDE)** is software that combines the tools required to write and test programs. An IDE can also be an app or web based software that facilitates the transfer of code to a device.

A **light emitting diode (LED)** is a semiconductor light source that emits light when current flows through it.

A **line follower** robot uses infrared sensors to detect where the robot is located relative to a line on a surface.

A **liquid crystal display (LCD)** is a flat-panel display that uses the light-modulating properties of liquid crystals.

A **load** is an electrical component that requires electric power to function.

Machine vision refers to technologies and processes used to extract information from an image on an automated basis.

Mechanical advantage is a measure of the advantage provided by using a too, mechanical device or machine system.

A **microcontroller** is a small computer on a single integrated circuit, containing a microprocessor, memory and programmable input and output peripherals.

A **motor controller** is a standard H-bridge motor driver that can turn wheels in both directions and can control two motors at the same time.

A **multimeter** is a testing device that can measure voltage, current and resistance in circuits.

Ohm's Law states that the current through a conductor is directly proportional to the voltage across the conductor and inversely proportional to the resistance of the conductor (I = V/R).

Output is information provided by a computer program or device.

Pairing is a process used to set up a linkage between computing devices, such as a radio transmitter and receiver.

A **parallel circuit** is an electric circuit that provides more than one pathway for electrical energy.

Pattern recognition is learning to identify and use similarities to simplify, shorten and apply similar solutions.

A **pictorial diagram** represents the elements of an electric circuit using simple images.

Pneumatic refers to the mechanical properties and uses of gases.

A **programming language** is a formal language which comprises a set of instructions used to produce various kinds of output.

A **prototype** is a model, or a test of a concept while working through the design process.

Pseudocode is an informal, high-level description of an algorithm or computer program, using natural language rather than the details of a formal programming language.

Radio-frequency identification (RFID) uses electromagnetic fields to identify and/or track tags attached to objects.

A **radio transmitter** is an electronic device that produces radio waves with an antenna.

A **radio receiver** is an electronic device that receives radio waves with an antenna and converts them to a usable form.

Relational operators, such as numerical equality (=) and inequalities (>, ≥, ≤, <), test or define a relationship between two entities.

A **relay** is an electrically operated switch.

Resistance is a measure of the opposition to the flow of electric current and is measure in ohms (Ω).

A **resistor** is a passive two-terminal electronic component that provides resistant to current flow in an electronic circuit.

Revolutions per minute (RPM) is a measure of rotational speed or frequency of rotation around a fixed axis.

Robotics is a branch of technology that deals with the design, construction, operation, and application of robots.

A **schematic diagram** represents the function of an electric circuit using lines to represent the wires and standard symbols to represent components.

A **semiconductor** is a material that has an electrical conductivity value between that of a conductor and that of an insulator.

A **sensor** is a device used to measure a physical property and respond with feedback.

A **series circuit** is an electric circuit that provides a single pathway for electrical energy.

A **servo** is a small electric motor that drives a train of reduction gears.

A **shield** is an add-on module for a microcontroller that performs a specified task.

A **sound sensor** is an electronic sensor that can detect the presence, frequency and/or intensity of sound.

A **stepper motor** is a brushless DC motor that divides a full rotation into a number of equal steps.

String refers to a data type made of any finite sequence of characters such as letters, words, numerals, symbols and punctuation marks.

Subroutine and routine are sometimes used interchangeably to describe a sequence of code written for a larger program. Subroutines are called and used by the larger program to complete a task.

The **syntax** of a computer language is the set of rules that defines the combination of words, phrases and context that comprise a correctly structured program.

A **tactile sensor** is an electronic sensor that measures information arising from physical interaction with its environment.

Tethering is the connection of a mobile device with other devices using a physical or wireless connection.

Torque is a measure of the force of rotational motion.

An **ultrasonic sensor** is an electronic sensor that converts ultrasound into electrical signals.

A **variable** is a storage location for data in a computer program.

A **visual programming environment** is a programming language that manipulates program elements graphically rather than textually.

Voltage is a measure of how much electrical energy each charged particle carries and is measured in Volts (V).

Voltage drop is a measure of how much the energy supplied by a voltage source as electrical current moves through passive elements of an electrical circuit.

Watt's Law states that the power is equal to the voltage times the current flow (W = VI).

Wearables, or wearable technology, are smart electronic devices that can be incorporated into clothing or worn on the body as implants or accessories.

Wireless is the transfer of information or power between two or more points that are not connected by a conductor.

A **wiring diagram** is a simplified visual representation of the physical connections and physical layout of an electric circuit or electrical system.

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