Outline of Course of Study

Faculty of Engineering Secondary School

Department of Engineering

Department Head: Carolyne Bjerring

Teacher: Anthony Cozzarini

Course development date: June 21, 2021

Course revisor: Julie Olivier

Revision Date: September 9, 2021

Course title: Computer Technology

Grade: 10

Type: Open

Ministry Course Code: TEJ2O

Credit value: 0.5 credit

Ministry curriculum policy documents:

- The Ontario Curriculum, Grades 9 and 10: Technological Education, 2009 (revised)
- Ontario Schools, Kindergarten to Grade 12: Policy and Program Requirements, 2016
- Growing Success: Assessment, Evaluation, and Reporting in Ontario's Schools, Kindergarten to Grade 12, 2010

Prerequisites and corequisites: none

Course Description

This course introduces students to computer systems, networking, and interfacing, as well as electronics and robotics. Students will assemble, repair, and configure computers with various types of operating systems and application software. Students will build small electronic circuits and write computer programs to control simple peripheral devices or robots. Students will also develop an awareness of related environmental and societal issues, and will learn about secondary and postsecondary pathways and career opportunities in computer technology.

Overall Curriculum Expectations

By the end of the course, students will be able to:

	A. COMPUTER TECHNOLOGY FUNDAMENTALS
A1	identify and describe the functions of, as well as important advances related to, electronic and computer components;
A2	demonstrate a basic understanding of computer networks and their components;
A3	demonstrate a basic understanding of binary numbers and digital logic.
	B. COMPUTER TECHNOLOGY SKILLS
B1	install and configure the hardware and operating system of a workstation, and use file management techniques effectively;
B2	construct and test simple interfaces and other electronic circuits;
B3	assemble and configure a simple computer network;
B4	install and use a variety of software;
B5	apply fundamental programming concepts to develop a variety of simple programs, including a program to control an external device.
	C. TECHNOLOGY, THE ENVIRONMENT, AND SOCIETY
C1	identify harmful effects of the widespread use of computers and associated technologies on the environment, as well as agencies that reduce these effects;
C2	identify effects of the widespread use of computers and associated technologies on society.
	D. PROFESSIONAL PRACTICE AND CAREER OPPORTUNITIES
D1	follow appropriate health and safety procedures when assembling, using, and maintaining computer systems;
D2	demonstrate an understanding of ethical and security issues related to the use of computers;

D3	identify various careers related to computer technology, and describe the education and/or training required for them.

Outline of Course Content

Unit 1: Introduction to Classical and Quantum Computing	**5 hours**
Students will get an overview of the course, learning about what problems *can* and *cannot* be tackled by computers. The unit will go into a basic introduction into quantum physics.	
Unit 2: Computational Thinking	**7.5 hours**
In this unit, students will learn about classical digital logic and computing. Students will apply the Engineering Design Cycle to build digital circuits, using truth tables and traditional gates. Students will learn the fundamental principles of computer programming, (I.e., if-else statements, loops, variables and functions). Students will build simple programs using Python.	
Unit 3: Quantum Information and Computing	**11 hours**
Students will use IBM's Circuit Composer to construct quantum circuits to demonstrate their understanding of quantum bits, two qubit gates, and electronic circuits. They will be introduced to quantum teleportation.	
Unit 4: Quantum programming using Qiskit	**8 hours**
In this unit, students will use classical and quantum registers alongside one qubit gates to code quantum circuits, using Python. Students will demonstrate their ability to apply fundamental programming concepts, and convert any quantum circuit into code that can be programmed on a quantum simulator.	
Unit 5: Course Project - Part 1	**10.5 hours**
In this unit, students work in groups to research and pitch a business idea that uses quantum technology.	
Unit 6: Mathematical Representation of Qubits	**5.5 hours**

Students will be introduced to the advanced mathematics that is used to model quantum technology. In groups, students will implement quantum gates using the quantum simulator, and present their work to their peers.	
Unit 7: Entanglement and Quantum Teleportation	**5 hours**
Students will use what they've learned thus far to build programs that demonstrate quantum entanglement and quantum teleportation, running their code on quantum simulators. Students will explore networking concepts, the basic components of a network in the context of quantum teleportation.	
Unit 8: Quantum Hardware and Advanced Algorithms	**1.5 hours**
In preparation for their final project, students will research the current quantum hardware. Students will have access to advanced content that could be useful for their final project.	
Unit 9: Course Project - Part 2	**10.5 hours**
For their final project, students will work in teams to use the quantum simulator to build a prototype for their business pitch.	

Teaching and Learning Strategies

This course is intended to give high school students a good understanding of computer technologies, the fundamentals of systems, networks and interfaces, and how they are applied through programming and quantum computing. We will be implementing several Active Learning elements to ensure that students remain engaged. Students will be introduced to classical computing fundamentals (circuits, bits, gates)
and learn foundational programming using Python (variables, functional programming, if/else statements, loops, etc.) in a hands-on way through interactive simulators, partially complete coding notebooks, and beginner-friendly assignments. Throughout the course, students will learn about and apply the Engineering Design Cycle, as it pertains to computing, with teacher support and guidance.

Group work will be a recurring theme throughout the course, allowing students an opportunity to advance their communication, problem solving, organization and collaboration skills. There will be regular, ongoing feedback provided by the teacher and peers. Students will have the opportunity to demonstrate their understanding of course concepts through quizzes, group activities, projects, and informal discussions.
The course will culminate in a final project – consisting of two parts – where students will be

expected to work in groups to research a quantum computing algorithm and application, formulate a ’business pitch’, and present a program they will write, with the guidance of the teacher, that will run on a quantum simulator. This final project will demonstrate the students’ understanding of the fundamental computing principles, develop their entrepreneurial skills, and consider the impact of technology (particularly quantum computing) on environmental and societal issues. This will also help them learn more about future career pathways and opportunities in computer technology and quantum computing.

Strategies for Assessment & Evaluation of Student Performance

Assessment, evaluation, and reporting of student achievement will be based on the policies and practices outlined in the following Ministry’s policy document Growing Success: Assessment, Evaluation, and Reporting in Ontario Schools, 2010.

Students will be evaluated based on the overall expectations of the course through the achievement charts in The Ontario Curriculum, Grades 9 and 10: Technological Education, 2009 (revised), as outlined in this document. The Ministry of Education’s document Growing Success: Assessment, Evaluation, and Reporting in Ontario Schools outlines policies for measuring and communicating achievement. Levels of achievement are defined as follows:

Level	Percentage	Achievement
Level 1	50-59%	Represents achievement that falls much below the provincial standard. The student demonstrates the specified knowledge and skills with limited effectiveness. Students must work at significantly improving learning in specific areas, as necessary, if they are to be successful in the next grade/course.
Level 2	60-69%	Represents achievement that approaches the provincial standard. The student demonstrates the specified knowledge and skills with some effectiveness. Students performing at this level need to work on identified learning gaps to ensure future success.
Level 3	70-79%	Represents the provincial standard for achievement. The student demonstrates the specified knowledge and skills with considerable effectiveness. Parents of students achieving at level 3 can be confident that their children will be prepared for work in subsequent grades/courses.

Level 4	80-100%	Identifies achievement that surpasses the provincial standard. The student demonstrates the specified knowledge and skills with a high degree of effectiveness. However, achievement at level 4 does not mean that the student has achieved expectations beyond those specified for the grade/course.

Seventy percent (70%) of the evaluation is based on daily classroom work and will be determined through a variety of methods, as outlined in the table below. Thirty percent (30%) of the evaluation will be based on a final design project which includes a prototype, presentation, and accompanying report. This final evaluation allows the student the opportunity to demonstrate comprehensive achievement of the overall expectations of the course.

Teachers will use "assessment for learning" and "assessment as learning" practices to help students identify: where they are in relation to the learning goals and what next steps they need to take to achieve the goals.

This ongoing feedback will help prepare students for "assessment of learning", the process of collecting and interpreting evidence for the purpose of summarizing learning at a given point in time, to make judgments about the quality of student learning on the basis of established criteria, and to assign a value to represent that quality.

Assessment breakdown for TEJ2O

Formative Assessment, 70% of final grade	Percentage of grade	Overall Expectation(s)
Assignment – Digital Logic	5%	A3, B2
Assignment – Programming in Python	5%	B5
Assignment – Circuit Composer	10%	A3, B2
Assignment - Programming with Qiskit	10%	B5
Assignment – Research Quantum Industry	5%	C1, C2, D2, D3

Presentation - Quantum Computing Business Proposal	15%	A1, A2, A3, B2, B3, B4, B5, C1, C2, D2, D3
Presentation – Single Qubit Gates	5%	A3, B5
Assignment – Quantum Teleportation	10%	A2, B3, B5
Assignment – Quantum Hardware	5%	A1, B1, D1

Summative Assessment, 30% of final grade	**Percentage of Grade**	**Overall Expectation(s)**
Quantum Computing Business Proposal: Theory Presentation and Simulation • Theory Presentation (15%) • Simulation / Prototype Demo (15%)	30%	A1, A2, A3, B1, B2, B3, B4, B5, C1, C2, D1, D2, D3

Considerations for Program Planning

Instructional Approaches

In technological education teachers will be using projects as a means for students to gain knowledge and learn new skills such that they can achieve the course expectations. Students will be actively engaged in their own learning through experiential learning strategies. Because of the online nature of this course, collaboration is more difficult so students' work is mostly independent although collaboration is encouraged while working through design and programming problems. When students are actively engaged in experiential learning, they tend to build longer-lasting skills and better retain knowledge.

Through hands-on lessons, students will work individually or in team. Step-by-step instructions and supplemental videos model new skills, and guide students through learning new coding skills. The teacher provides direction, clarification and support until students are confident in using their new skills independently. Teachers model good program design and good coding practices to set students off on the right foot, and give them ample time to practice new skills.

With the support of teacher modelling and ample time for practice, students will gain understanding and develop new skill sets in manageable chunks. This scaffolding approach will provide students with the support they need to reach manageable objectives.
.

The Importance of Current Events in Technological Education

The discussion of current events and emerging technologies stimulates student interest and may be included in the Computer Technology curriculum. It enhances the relevance of the curriculum and helps students connect their lessons with real-world events or situations. Embedding current events into the lessons is an effective instructional strategy for implementing many course expectations into the curriculum.

The Role of ICT in Technological Education

Information and communications technologies (ICT) tools allow teachers to expand their instructional strategies and support student learning. These tools include Internet websites, Youtube videos, slideshows, class forums and other multimedia resources. These tools help students collect, organize, and present data for reports and presentations. They also enable students to connect with each other and the world to be able to share ideas and collaborate on learning.

Students will be encouraged to use ICT tools for most of the course in order to learn new skills and communicate their learning. Students will have the choice of technologies they use for delivering their presentations on the impact of computers on society and to present their final app design projects to the class.

With the power of the Internet comes potential risks such as privacy, safety, and abuse of technology in the form of bullying or other malicious acts. Students must be made aware of these issues and teachers will model appropriate behaviour in their instruction. Teachers can also make use of ICT tools in their day-to-day teaching practice of curriculum design and in-class teaching.

Planning Technological Education Programs for Students with Special Education Needs

Teachers have a duty to ensure that all students in their class have the opportunity to learn and succeed regardless of their special education needs. *Special Education Transformation: The Report of the Co-Chairs with the Recommendations of the Working Table on Special Education, 2006* promotes a set of beliefs that should guide program planning for students with special education. These beliefs include:

- All students can succeed.
- Universal design and differentiated instruction are effective and interconnected means of meeting the learning or productivity needs of any group of students.
- Each student has his or her own unique patterns of learning.
- Teachers need the support of the larger community to create a learning environment that supports students with special education needs.
- Fairness is not sameness.

Teachers are encouraged to develop their program plan in accordance to their students' diversity of strengths and abilities. This can be achieved through a myriad of ways including: assessing each student's prior knowledge and skills, providing ongoing assessment, and allowing for flexible groupings. By assessing each student's current achievement level and weighing that against the course expectations, the teacher can determine if the student will be requiring any combination of: accommodations, modified expectations, or alternative expectations. If the student requires accommodations, modified expectations, or both, the information must be recorded in their Individual Education Plan (IEP).

Students Requiring Accommodations Only

Accommodations that are required by students must be identified on their IEP. Differentiated instruction and universal design lend themselves well to providing accommodations for students. Students will still be evaluated on the curriculum course expectations and achievement levels communicated by the Ministry.

There are three types of accommodations:

- Instructional accommodations: Teachers change the way in which lessons are taught including integrating technology and using different styles of presentation.
- Environmental accommodations: This includes a change in the learning environment whether it be classroom seating by location or group, or lighting.
- Assessment accommodations: These allow students to demonstrate their learning in a different way. For instance, they may be given the opportunity to give oral answers to written questions or they may be given more time to complete an assignment or test.

Students Requiring Modified Expectations

Modified expectations that are required by students must be identified on their IEP. For the most part, these expectations will be based on the regular course expectations but the number and/or complexity will differ. Modified expectations are specific, realistic, and measurable achievements that the student can demonstrate independently, given assessment accommodations.

It is the principal who will decide whether the achievement of the modified expectations constitutes successful completion of the course and whether the student is eligible to receive a credit for the course; this decision must be communicated to the student and their parents.

When course expectations are not extensively modified and it is expected that the student can achieve most of them, the modified expectations should determine how the required knowledge and skills differ from those identified in the course expectations. In the case, if the student is working toward a credit for the course, the IEP box must be checked on the Provincial Report Card.

With extensive modifications to expectations such that achievement of them is not expected to result in a credit, the expectations should identify the precise requirements or tasks on which the student's performance will be evaluated and which will be used to determine the student's mark on the Provincial Report Card. The IEP box must be checked and the appropriate statement from the *Guide to the Provincial Report Card, Grades 9-12, 1999* (p. 8) must be added. Modified expectations must be reviewed in relation to the student's progress at least once each reporting period, and must be updated as necessary.

Program Considerations for English Language Learners

Schools in Ontario have a very diverse and multicultural student population, such that 20% of students have a language other than English as their first language. These English language learners may be recent immigrants or refugees while others may be born in Canada into a family whose primary home language is either not English or is an English dialect differing significantly from the English taught in Ontario schools. Teachers must be mindful that many of these students are entering a new linguistic and cultural environment at school.

During their first few years in an Ontario school, English language learners may receive support through English as a Second Language (ESL) programs or English Literacy Development (ELD) programs. ELD programs are primarily for newcomers who arrive with significant gaps in their education, often due to limited opportunities (in terms of education and literacy) in their home country.

It is important that teachers recognize the orientation process whereby English language learners adapt to a new social environment and language. Some may be very quiet at first, using body language rather than speech and/or limited verbal communication to convey their thoughts. These students thrive in a safe, supportive, and welcoming environment. As the students learn to speak English, it is important to note that oral fluency is not a good indicator of the student's literacy development and vocabulary.

It is the shared responsibility of the classroom teacher, the ESL/ELD teacher (where available), and other school staff to help in the development of students' English. Volunteers and peers may also provide significant support. Teachers are required to adapt their instruction to facilitate the success of their English language learner students. These adaptations may include:

- Modifying some or all course expectations such that they are challenging yet achievable given the student's English proficiency
- Using a variety of instruction strategies, such as visual cues, pre-teaching vocabulary, offering peer tutoring
- Using a variety of learning resources, such as bilingual dictionaries, visual material, simplified text
- Modifying assessments, such as giving extra time, offering the choice of demonstrating skills/knowledge orally or in writing, assigning cloze sentences instead of essays

When learning expectations are modified for an English language learner, it must be clearly indicated on their report card.

Equity and Inclusion Education in Technological Education

The Faculty of Engineering Secondary School abides by the University of Ottawa's Violence Prevention Policy and Prevention of Harassment and Discrimination Policy. These policies encourage staff and students to show respect for diversity in the school and the wider society. The policies aim to provide a safe learning environment, free from violence, harassment, and discrimination.

Differentiated instruction will be at the core of curriculum planning. By assessing each individual student's abilities, background, interests and learning styles, teachers can design their lessons based on the needs of their diverse students. The course content (what is being taught), process (how it is taught), and product (how students demonstrate their learning) will be designed in relation to the students' needs.

Generally, in technical courses such as computer science there is a clear gender disparity. Studies have shown that female students are often drawn to courses that have a societal aspect to them, rather than just abstract learning. It may be helpful for teachers to offer projects and activities that have a clear and meaningful societal application. For instance, instead of being asked to design a robotic arm (whose purpose is unknown), teachers can give students the option of designing an assistive device. Differentiated instruction offers students a choice from a range of activities or allows them to select their own projects; by giving students the power to choose their own topic, they can select something that most interests them and become more invested in the project.

Environmental Education in Technological Education

It is important for students to understand their environmental impact in the world and how they can better the environment they are living in. It is the duty of the teacher to integrate environmental education into their curriculum planning such that students understand their personal responsibility to the environment and their role in society.

Environmental education can be integrated into the classroom in a variety of ways. In selecting their projects, students can go the environmental route and select a project that is directly linked to environmental impact, such as a simulation of a healthy ecosystem. Additionally, students can focus on the environmental impact of computer use by learning about the safe handling and disposal of materials used in the manufacturing of computer components. By implementing strategies to reduce, reuse and recycle, students can learn about government agencies and community partners that support such practices. This will give students the opportunity to develop critical thinking skills and responsible practice with respect to environmental implications of their selected project.

Programming projects can be used to address environmental-focused course expectations. For instance, students can program a survey that assesses people's environmental awareness as it relates to the use of computers. The program could calculate the awareness and suggest strategies or provide feedback to users.

Literacy, Mathematical Literacy, Financial Literacy, and Inquiry/Research Skills

Many activities in the computer studies curriculum requires students to practice and develop oral, written, and visual literacy skills. Students will be required to brainstorm ideas and effectively communicate them to their team members. They will need to be able to justify their choices for decisions taken in the design process and will need to be able to communicate them clearly to their audience in an oral presentation with visual support. They will be required to compose written reports on their progress and outline the steps taken during the design process in order to effectively convey their message to the reader. Students will be learning specialized terminology which they will be expected to use appropriately and precisely in their communication.

In developing programs, students will build on their mathematical literacy. Students will be required to communicate clearly and concisely through the use of tables, diagrams, and/or flow charts. Many components of the computer technology curriculum emphasize students' ability to interpret and use symbols and charts.

While learning about the different components of a computer, both hardware, software, and operating system, students will understand the importance of making good economical choices when choosing or buying a computer. Financial literacy connections may be made as students learn about their place in the world, as a responsible and compassionate citizen and through critical thinking, decision-making and problem solving that can be applied to real life situations.

In conducting research for their projects, students will be required to explore a variety of possible solutions to their challenge, analysing the context of their data and properly interpreting it. They will be required to analyse the source of their information, determine its validity and relevance, and use it in appropriate ways. Teachers can support students by guiding them toward reputable sources including peer-reviewed journals. The ability to locate, question, and evaluate information allows a student to become an independent, lifelong learner.

The Ontario Skills Passport and Essential Skills

The Ontario Skills Passport (OSP) is a web-based service that can track students' Essential Skills (such as reading, writing, and problem solving) and work habits (such as working safely and being reliable). These skills and work habits are easily transferable from school to work and are useful for employers looking to assess potential candidates for cooperative education placements. The OSP is also useful for students looking to assess, build, document, and track their skills through their educational, professional, and personal experiences. More information about the OSP can be found on the ministry website, http://skills.edu.gov.on.ca.

The Ontario First Nation, Métis, Inuit Education Policy Framework

The Ontario First Nation, Métis, and Inuit Education Policy Framework is based on the vision that all First Nation, Métis and Inuit students in Ontario will have the knowledge, skills and confidence they need to successfully complete their secondary education to pursue postsecondary education or training and/or to enter the workforce. They will have the traditional and contemporary knowledge, skills, and attitudes required to be socially contributive, politically active, and economically prosperous citizens of the world. All students in Ontario will have knowledge and appreciation of contemporary and traditional First Nation, Métis, and Inuit traditions, cultures, and perspectives.

The Faculty of Engineering Secondary School abides by the goals stated in the Ontario First Nation, Métis, and Inuit Education Policy Framework to provide a supportive and safe environment for all FNMI students. These goals include:

- Increase the level of student achievement
- Reduce gaps in student achievement
- Increase the levels of public confidence

For example, the school will strive to develop awareness among teachers of the learning styles of First Nation, Métis, and Inuit students and instructional methods designed to enhance the learning of students, such as incorporating meaningful First Nation, Métis, and Inuit cultural perspectives and activities when planning instruction, and implementing strategies for developing critical and creative thinking.

The First Nation, Métis, and Inuit students will also have access to the support, activities and resources offered by the uOttawa Indigenous Resource Centre Mashkawazìwogaming. For example, students can have access to student mentoring from a university student, individual or

group meeting with and Elder in residence, and social and cultural events to participate in, if they wish to.
The Faculty of Engineering Secondary School, as part as the University of Ottawa also supports the uOttawa Indigenous Action Plan Framework for 2019-2024 which is designed to facilitate the inclusion of First Nation, Métis, and Inuit students and support the specific needs of the indigenous community.

Career Education

In this era of technological innovation with rapidly evolving technologies, employers are always on the lookout for candidates with strong technical skills who can problem-solve effectively, think critically, and work collaboratively. These are the exact skills that will be developed through computer studies courses. In going through the design process, students will develop skills in: research, analysis, creativity, problem-solving, design, and presenting. They will practice these skills through both independent and group work.

Cooperative Education and Other Forms of Experiential Learning

Cooperative education and other forms of experiential learning, such as job shadowing, work experience, and field trips, allow students to apply the skills they've learned in the classroom to real-word work environments. They help students learn about the possible careers and employment opportunities in various fields of work, as well as broadening their knowledge of workplace practices and employer-employee relationships.

Students who choose a computer studies course as the related course for two cooperative education credits are able, through this packaged program, to meet the group 1, 2, and 3 compulsory credit requirements for the OSSD.

Teachers must assess the health and safety of placements and ensure that their students understand their rights as they relate to health and safety, privacy and confidentiality, and abuse and harassment in the workplace.

All cooperative education and other workplace experiences will be provided in accordance with the ministry's policy document *Cooperative Education and Other Forms of Experiential Learning: Policies and Procedures for Ontario Secondary Schools, 2000*.

Health and Safety in Technological Education

The most common health and safety concerns associated with repeated computer use are eye strain and musculoskeletal injuries (including repetitive strain injuries). Teachers will ensure that work stations are ergonomic and that students maintain good posture and take frequent eye and body breaks. Students will also be taught about emotional and health risks common among heavy computer users, particularly social isolation.

Students will be trained on how to safely use all technological equipment required for the class, particularly microcontrollers. Teachers will model proper procedures and safe practices, warning students of possible dangers inherent in using the equipment. Students must be able to demonstrate knowledge of how the equipment is used and what procedures must be followed to ensure its safe use.
Any practice will comply with relevant health and safety regulations including, but not limited to:

- the Ontario Workplace Safety and Insurance Act
- the Workplace Hazardous Materials Information System (WHMIS)
- the Food and Drugs Act
- the Ontario Health Protection and Promotion Act
- the Ontario Building Code
- the Occupational Health and Safety Act
- local by-laws

While teachers are responsible for their students' safety during a technology lab, they will encourage students to take responsibility of their own safety and that of others. They will support students in developing the knowledge and skills required to stay safe and maintain a safe learning environment for all students.

Resources

No textbook is required for this course, although the teacher will supply articles and blogs for students to read in order to extend their knowledge of the course. Students will be given access to all course material in class and will be given access to computer laboratories during and after class hours in order to continue their learning. Students will also be given access to any system required for the course.