

Outline of Course of Study – TDJ10

Faculty of Engineering Secondary School

Department of Engineering

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Teacher: TBD

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Course reviser: Pamela Lee-Shanok

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Course title: Exploring Technological Design

Grade: 9

Type: Open

Ministry Course Code: TDJ10

Credit value: 1.0 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 exploratory course introduces students to concepts and skills related to technological design, which involves the development of solutions to various design challenges and the fabrication of models or prototypes of those solutions. Students will develop an awareness of related environmental and societal issues, and will begin to explore secondary and postsecondary pathways leading to careers in the field.

Overall Curriculum Expectations

By the end of this course, students will:

A. TECHNOLOGY FUNDAMENTALS	
A1	demonstrate an understanding of the fundamental concepts and skills required in the planning and development of a product or service, including the use of a design process and/or other problem-solving processes and techniques;
A2	demonstrate the ability to use a variety of appropriate methods to communicate ideas and solutions;
A3	evaluate products or services in relation to specifications, user requirements, and operating conditions;
B. TECHNOLOGICAL SKILLS	
B1	use problem-solving processes and project-management strategies in the planning and fabrication of a product or delivery of a service;
B2	fabricate products or deliver services, using a variety of resources;
C. TECHNOLOGY, THE ENVIRONMENT, AND SOCIETY	
C1	demonstrate an awareness of the effects of various technologies on the environment;
C2	demonstrate an awareness of how various technologies affect society, as well as how society influences technological developments;
D. PROFESSIONAL PRACTICE AND CAREER OPPORTUNITIES	
D1	follow safe practices and procedures when using materials, tools, and equipment;
D2	identify careers in various technological fields, and describe the educational requirements for them.

Outline of Course Content

Unit 1: The Design Process – 7 hours
Students will explore the design process, understand its usefulness and effectiveness in engineering and will apply this process throughout the course.
Unit 2: 3D Modelling and 3D Printing – 12 hours
Students will immerse themselves in the CAD/CAM software Solidworks, where they will learn to model given objects in three-dimensions and design their own objects as well.
Unit 3: Engineering Project Design: Prototyping – 17 hours
Using the skills they have learned in the previous units, students will embark in an engineering design challenge by creating a prototype that solves a defined problem. They will conduct research, brainstorm ideas, and analyse various designs to create their prototype
Unit 4: Engineering Project Design: Final Product – 18 hours
Using feedback from the teacher and their peers, students will improve upon their design through various iterations until they have developed the best prototype. The culmination of this task is a presentation to the class, which outlines their journey through the design process.
Unit 5: Introduction to Arduino – 6 hours
Students will learn about microcontrollers in everyday life and will learn the basic hardware and software associated with the Arduino microcontroller
Unit 6: Temperature and Light Sensors – 6 hours
Through a guided, hands-on lesson, students will learn how to use common Arduino components such as temperature and light sensors.
Unit 7: Ultrasonic Motion sensors – 6 hours
Students will learn how to incorporate ultrasonic motion sensors with their Arduino to be able to measure distances and detect motion.
Unit 8: Servo Motors – 6 hours
Students will learn how to code and actuate a servo motor using an Arduino.
Unit 9: Engineering Project Design: Prototyping – 18 hours
Using the skills they have learned in the previous units, students will embark in a Arduino-based engineering design challenge by creating a prototype that solves a defined problem.

They will conduct research, brainstorm ideas, and analyse various designs to create their prototype

Unit 10: Engineering Project Design: Final Product – 18 hours

Using feedback from the teacher and their peers, students will improve upon their design through various iterations until they have developed the best prototype. The culmination of this task is a presentation to the class, which outlines their journey through the design process.

Teaching & Learning Strategies

This course is intended to give high school students a good understanding of technological design, as it is applied through 3D modelling, 3D printing, and microcontrollers; the microcontroller used in this course is Arduino. Our goal is to keep students engaged and curious by having them ‘learn by doing.’

In the first half of the course the teacher will model safe use of the 3D printers and will guide students through the design process. Solidworks (a 3D computer-assisted design and modelling software) will be taught through hands-on lessons, where the students can follow the teacher’s instruction. Students will be given class time to develop their skills on Solidworks with teacher support and guidance. Students will also be given access to a 3D printer in order to print out various iterations of their prototypes.

In the second half of the course the teacher will model safe use of the Arduino board including all its peripheral components and will guide students through the design process. Use of the Arduino and its components (LEDs, sensors, motors, etc.) will be taught through experiential lessons, where the students can follow the teacher’s instruction. Students will be given class time to develop their skills with the Arduino with teacher support and guidance.

As it is common in engineering projects, group work will be a big part of this course. Group work will allow students to practice a variety of skills including: problem solving, organization, communication, and collaboration. Teachers will offer ongoing feedback and will regularly check for understanding through informal discussions and quizzes for assessment for learning.

Through peer feedback offered by students to students (assessment as learning), prototypes will be refined into their final design.

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 TDJ101:

Formative Assessment, 70% of final grade	Percentage of grade	Overall Expectation(s)
Assignment: Design Process and Product Development	5%	A1, A3
Quiz: 3D modelling and printing	2%	D1
Assignment: 3D modelling on Solidworks	3%	B2
Assignment: Problem Definition, Research	5%	B1, C1, C2
Assignment: Analysis of Solutions and Conceptual Design	5%	A3, B1, C1, C2
Presentation: 2-minute pitch of prototype	5%	A2, D1
3D Design Project: Prototype, report, presentation	15%	A1, A2, A3, B1, B2, C1, C2, D1, D2
Assignment: Microcontrollers in everyday life	3%	C1, C2, D2
Assignment: Arduino - LEDs	3%	A1, B1, B2
Assignment: Arduino - Temperature and light sensors	3%	A1, B1, B2
Assignment: Arduino - Ultrasonic motion sensors	3%	A1, B1, B2
Assignment: Arduino - Soldering	3%	A1, B1, B2
Assignment: Problem Definition, Research	5%	B1, C1, C2
Assignment: Analysis of Solutions and Conceptual Design	5%	A3, B1, C1, C2
Presentation: 2-minute pitch of prototype	5%	A2, D1

Summative Assessment, 30% of final grade	Percentage of grade	Overall Expectation(s)
Final evaluation: Design Project <ul style="list-style-type: none"> ● Prototype (10%) ● Report (10%) ● Presentation (10%) 	30%	A1, A2, A3, B1, B2, C1, C2, D1

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. This type of course will give students ample opportunities to collaborate in teams and work cooperatively while working through the design process: brainstorming ideas and issues, researching solutions, analyzing possibilities, developing solutions, testing prototypes, and improving designs. Students will be actively engaged in their own learning through experiential learning strategies.

Through activity-based lessons, students will be given the opportunity to work individually and in teams. Teachers will model new skills, offering direction and support until students are confident in using those skills independently. By following the design process and actively problem-solving, 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.

Group role play will allow students to internalize the engineering problem that will guide them to designing an innovative solution to a current societal issue. They will work collaboratively in groups, where each student has a specific role on the design team. Using emerging technologies such as 3D printers and Arduino micro-controllers, students will have the opportunity to actively use their newly-developed skills to solve real problems.

Health and Safety in Technological Education

Students will be trained on how to safely use all technological equipment required for the class, such as 3D printers and Arduino micro-controllers. 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.

Classroom 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.

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 Role of Information and Communications Technology 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, word-processing programs, and 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 projects.

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 be using Power Point, for instance, to present their 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

Classroom 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.
- Classroom 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 pay 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.

Antidiscrimination 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 technological design 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), teacher 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.

In 2019 we will have a wonderful teacher (doubling as a role model) for our class. Our Exploring Technological Design course (TDJ10) will be taught by a visible minority. He will

guide the class toward developing their own technology fair, where they will showcase their prototype designs to the university staff and students, as well as to the participants attending the engineering and science camp at the Faculty of Engineering. The high school students themselves will be able to explore the engineering products designed by their peers, further encouraging their interest in technological education.

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 design projects, students can go the environmental route and select a project that is directly linked to environmental impact, such as a hydroponic system or a solar-powered vehicle. Additionally, students can focus on the environmental impact of their design by learning about the safe handling and disposal of materials used in the development of their device. 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.

Literacy, Mathematical Literacy, and Inquiry/Research Skills

Many activities in the technological education 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 and working with engineering drawings and 3D models, students will build on their mathematical literacy. Students will be required to communicate clearly and concisely through the use of tables, diagrams, and/or engineering drawings. Measurements will need to be perfectly accurate with respect to their designs, as 3D printed parts will need to fit together during assembly.

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.

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 technology education. In going through the engineering 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-world 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 technological education 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*.

Planning Program Pathways and Programs Leading to a Specialist High Skills Major

Technological education courses are well suited for programs leading toward a Specialist High Skills Major (SHSM) or programs leading toward an apprenticeship or workplace destination. Technological education courses can also be combined with cooperative education credits in order to provide the workplace experience necessary for some SHSM programs,

apprenticeships, and workplace destinations. SHSM programs would also include sector-specific learning opportunities offered by employers, skills-training centres, colleges, and community organizations.

Resources

No textbook is required for this 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 equipment required for the course, such as 3D printers and Arduinos.