



**Artificial Intelligence Systems Engineering (AISE)
New Program Proposal
Final Assessment Report & Implementation Table**

Faculty / Affiliated University College	Faculty of Engineering
Degrees Offered	Bachelor of Engineering Science (BESc)
Program / Module(s) Reviewed	The proposed AISE program will be offered as a dual degree program when combined with an existing accredited engineering degree program offered by Western’s Faculty of Engineering.
External Consultants	Dr. Qusay Mahmoud, Professor of Software Engineering & Associate Dean for Experiential Learning and Engineering Outreach, Faculty of Engineering and Applied Science University of Ontario Institute of Technology Dr. Cheng Li, Department Head, Electrical and Computer Engineering Memorial University
Internal Reviewer	Dr. Christopher Sherrin, Associate Dean (Academic), Western Law
Date of Site Visit	November 22, 23 & 26, 2021
Evaluation	Approved to Commence
Approval Dates	SUPR-U: January 26, 2022 SCAPA: February 9, 2022 Senate:
Year of Next Review	

Executive Summary

Overview

Western possesses the resources and expertise to offer a unique AISE undergraduate program that will effectively balance traditional technical engineering subjects, fundamental Artificial Intelligence (AI), applications of AI to address engineering problems, and participation in internationally leading AI research to produce graduates who are well prepared for both employment in the industry and for further graduate or professional studies.

The distinctive features of Western’s AISE program will be (1) its foundation in a single traditional engineering discipline that includes all of the requirements through the fourth-year

level, which will maximize the employability of its graduates, (2) AISE-specific and signal processing-based courses that are highly interdisciplinary, explicitly linking each of chemical, civil, electrical, mechatronics and mechanical engineering to the data sciences, and (3) various project-based design courses that include a significant amount of design activities.

Students enrolled in the Western Engineering AISE program will develop the following skills/foundations:

- **Applied Probability and Statistics:** Students will be introduced to the theory of statistics with strong links to data as well as its probabilistic underpinnings.
- **Computing & Software Development Skills:** Students will develop good understanding of Algorithms, Data Manipulation, Data Structure for Big Data, Databases Design and Management.
- **Signal Processing and System Design:** Students will be introduced to various signal processing and system designs.
- **IoT Networks and Systems:** Students will be introduced to Network Protocols/Performance, Security and IoT Systems.
- **Machine Learning and Data Engineering:** Students will be introduced to various Machine Learning Algorithms, Data Engineering & Pipelining with a focus on discipline-specific problems.

Students will enter the AISE program as a dual degree together with an accredited engineering program after successful completion of the Engineering common first year. The AISE program enrollment is expected to be ~150 students/year in total, drawn from students who would have otherwise selected one of the nine existing engineering programs.

Program Proposal Preparation and Review Process

As per the new program proposal process outlined in Western's IQAP, consultations took place with:

- the Electrical Engineering Curriculum Committee
- the Department of Electrical and Computer Engineering
- the Department of Mechanical and Materials Engineering
- the Chemical and Biomedical undergraduate committee
- the Department of Chemical and Biomedical Engineering
- the Department of Civil and Environmental Engineering
- Christopher Mohan (President) and Jennifer Villeneuve (VP Academic), Undergraduate Engineering Students (UES) Society
- Kristina Sendova, Chair, Department of Statistical Sciences
- Hanan Lutfiyya, Chair, Department of Computer Science
- Joern Diedrichsen, Chair, Western, Data Science Committee
- Matt Davison, Dean, Faculty of Science
- Mark Daley, Special Advisor to the President on Data Strategy

An external review by Dr. Qusay Mahmoud of University of Ontario Institute of Technology & Dr. Cheng Li of Memorial University then took place, consisting of the review of the AISE new program proposal document and a series of Zoom meetings on November 22, 23 & 26 2021. Following the virtual site visit, the external reviews produced a comprehensive review report with recommendations which was sent to the interim program director and the Associate Dean of the Faculty for review and response. These formative documents, including the new program

proposal document, the external reviewer report, and the program and Faculty responses, have formed the basis of this summative assessment report of the new AISE Program.

The external reviewers commended the program development team and stated: “We feel that the Faculty of Engineering at Western has the collective expertise to deliver this state-of-art and timely AI-based engineering undergraduate program.” In their review report they shared perspectives on the strengths, issues for consideration and resulting recommendations, as presented in the following sections.

Strengths of the Program

The following program strengths and unique features are identified in the External Reviewers’ Report:

- Opportunity for the University to play a leadership role in this new emerging area of Artificial Intelligence (AI) / Machine Learning (ML);
- Faculty-wide dual degree program format for Engineering students;
- Consistency with Western’s mission and strategic priorities and alignment with its AI/Data Science initiative;
- Program development team has outstanding research and teaching experience in AI/ML and applying AI/ML-based techniques to solve engineering problems;
- Bottom-up approach to properly prepare students for the field;
- Program provides sufficient background for students outside of the field to prepare them well for the courses in AI/ML; and
- Proposed methods of assessment follow the current best practices established in the Faculty and are quite appropriate.

Opportunities for Program Improvement and Enhancement

The external reviewers invited consideration of the following elements:

- A specific learning outcome under ‘Knowledge’ for demonstrating an understanding of, and reducing bias in, machine learning and artificial intelligence applications, and ethical implications, legality and privacy concerns when developing machine learning algorithms and applications;
- Developing a path for students in the core Engineering programs (including Software Engineering) to have at least a couple of possible electives related to AI/ML – particularly for students who are interested in this field and cannot be admitted perhaps due to capacity;
- A certificate option for students from the Software Engineering program, given that the AISE dual degree option is not available to them; and
- As there are now many public cloud service providers with state-of-the-art computing resources including GPUs, consider investing in at least one technical staff member with expertise in using ML in the cloud to support the program.

Summary of the Reviewers' Key Recommendations and Program / Faculty Responses

Reviewers' Recommendations <i>Recommendations requiring implementation have been marked with an asterisk (*).</i>	Program / Faculty Responses
<p>Recommendation 1: Expand the description of the program for the Calendar Copy. The proposed description focuses on foundational and technical aspects of AI, and we recommend expanding the description to include human-in-the-loop (AI-human interaction), bias, ethical/legal/security/privacy/safety/social implications.</p>	<p>Program: The Engineering AISE program committee agrees with this recommendation. A new compulsory course "AISE 3020A/B: AI Ethics, bias and privacy" has been added to the AISE program curriculum. Moreover, all students have to take the compulsory engineering course "ELI 4110g: Engineering Ethics, Sustainable Development, and the Law." ELI 4410g covers professionalism, ethical theory, the code of ethics and enforcement; the environment; and contracts and risk.</p> <p>Faculty: Agreed and implemented</p>
<p>Recommendation 2: Develop a clear plan for EDI. From various meetings we have learned that the focus in EDI has been on the gender-balance and we were told that approx. 25% of female students came to first year Engineering last year, which is an impressive number and might be at or above the national level, but all Engineering programs have less than 1% of students who have identified as indigenous. We recommend developing a clear plan for EDI - to diversify the student body, faculty, and staff members. As a side note, the new program template should have a section on EDI.</p> <p>When students apply to first year Engineering in general and not directly to a specific program, how do you ensure equity and students get their first choice especially if they are interested in the AISE program?</p>	<p>Program: Western Engineering has established the Equity, Diversity, and Inclusion (EDI) steering committee in 2021. Western Engineering Faculty Council approved the committee terms of references on September 13, 2021. The terms of references are available at https://www.eng.uwo.ca/files/ToR-WE-EDI-Committee.pdf. The Western Engineering EDI Steering Committee was established to develop high-level recommendations to Western Engineering Dean's Council in creating and maintaining an inclusive and safe environment for all underrepresented groups in the Faculty (e.g., women, persons with disabilities, Indigenous Peoples, racialized minorities, individuals from the LGBTQ2+ community).</p> <p>Moreover, Western Engineering has introduced in 2018 the Connect Profile – a Supplemental Admission Form. Students are encouraged to fill out a CONNECT profile and connect their grades with all the incredible things that make them unique. This application is used as an EDI tool to increase diversity within Western Engineering. Since implemented for the class of 2018, Western Engineering has seen the % of female students increase by almost 4%.</p> <p>Western Engineering is continuously striving to promote equity, diversity and inclusion. For example, Western Engineering is currently in the process of establishing Undergraduate Scholarships for Indigenous students. In addition, the Western Engineering recruitment steering committee has decided that a minimum of 50% of the new faculty members that will be recruited to support the AISE program will be females.</p>

<p>The AISE program committee will continue to work closely with Western Engineering EDI steering committee, and various Western Support Services to adhere and be up-to-date with the EDI best practices.</p> <p>Faculty: While the Faculty recognizes the importance of EDI, there was question as to whether this falls within the scope of a program. The program response outlines the steps taken at the Faculty level to ensure that the principles of EDI are incorporated in all aspects of Faculty operations. In response to the final question in the reviewers' comments, admission to all programs following the common first-year is currently based solely on academic performance subject to capacity limits in the program of choice.</p>	<p>Recommendation 3: Revisit the proposed curriculum and add more AI/ML related courses to justify the title in the degree nomenclature. To this end, we recommend:</p> <ul style="list-style-type: none"> a) Reduce the number of 'Probability and Statistics' courses from two to one. b) Reduce the number of 'Data Structures' courses from two to one. Advanced algorithms related to AI/ML algorithms can be covered in AI/ML related courses. c) Reduce the three courses 'Digital Systems and Signal Processing', 'Cyber-Physical Systems Theory', and 'Intro to Computer Networking, Security & IoT Systems' to two courses. Since these are new courses being developed, we believe it is possible to cover the relevant topics in two courses. <p>The above three suggestions will create space for three new AI/ML courses, so we would recommend adding the</p>
<p>Program:</p> <ul style="list-style-type: none"> a) The program agrees with the recommendation to reduce the number of "Probabilities and Statistics" courses from two to one. The two probability and Statistics courses will be replaced by Statistical Sciences 2141 A/B course. Note that this course is a compulsory course in all engineering programs at Western. The AISE program committee recommends the current practices of introducing/reviewing additional Statistics contents in the Data Science 3000 A/B course. b) The program agrees with the recommendation. The second Data Structure course (SE 22X2 A/B: Advanced Algorithms and Data Structure) is now removed from the curriculum. Moreover, the AISE 3010A/B – Data Engineering and Machine Learning course is restructured to include selected topics from the second Data Structure course that was eliminated. Specifically, AISE 3010A/B is updated to cover topics related to data manipulation and data structure for big data. c) The program does not agree with this recommendation. The three proposed courses are essential for future engineers to acquire the fundamental knowledge and engineering skills needed to be able to understand, design and develop end-to-end engineering systems and the whole ML/AI pipeline (i.e., a device capturing/sensing the physical signal, pre-processing of the signals, transmitting/moving the signal/data to ML engines/storage, and closing the loop by sending a command back to the machine). <p>Reducing the number of "Probabilities and Statistics" courses to one and the number of "Data Structure and Algorithms" to one have created two spots in the curriculum. These two spots are replaced with: i) the new AISE 3020A/B: AI: Ethics, bias and privacy course; and ii) a new</p>	

<p>following three courses as required courses:</p> <ul style="list-style-type: none"> • 'Introduction to Artificial Intelligence'. An intro course in the second semester of year 2. • 'Deep Learning'. An advanced course for the second semester of year 4. • 'Values and Implications of AI'. A course to cover topics such as bias, ethical/social/legal implications, security, privacy, and safety of AI systems. <p>d) Differentiate between AISE 40X1 and 40X2. Perhaps change the title of 40X1, so it is clear 40X2 is a two-semester capstone project.</p>	<p>AISE 4010A/B Deep Learning for time series data course. The new Deep Learning course focuses mainly on time series based Deep Learning techniques.</p> <p>d) AISE 4050 is a 1.0 credit course. Senior Western undergraduate students are familiar with the course credit and suffix conventions and it would be clear for them that this is a two-semester course. Moreover, this would be clear in the program progression sheet. Western Engineering keeps up-to-date progression sheets for all program at: https://www.eng.uwo.ca/electrical/undergraduate/Current-Students/Program-Progression-Sheets.html. Once approved, the AISE program progression sheets will be added.</p> <p>Faculty: a), b) and d): The Faculty equally agrees with these implemented recommendations.</p> <p>c) The Faculty does not agree – concurring with the reasoning provided in Dr. Shami's program response.</p>
<p>Recommendation 4: Add AI/ML technical electives. All core Engineering programs have several technical electives and students in the proposed AISE program should have a list of AI/ML electives that are either general (open to all Engineering students in AISE) or specific to their program. Another alternative to the module-based or section-based courses is to make the required AI/ML courses general enough, and have at least two AI/ML electives for each of the core Engineering programs - as an example, for EE there could be several AI/ML electives that students in EE (and possibly other programs) can choose from: Natural Language Processing, Computer</p>	<p>Program: AISE students have to complete a minimum of two AI-based technical electives from a pre-approved list by the AISE program committee. The list will include courses from the Faculty of Science and Engineering (CS4442 A/B Artificial Intelligence II and SS 4850 A/B Advanced Data Analysis). Note that the ECE department recruited four new faculty members that joined/will join in January 2022 or July 2022. These new faculty members will introduce new AI-based TE undergraduate courses in collaboration with the AISE committee. In addition, Western Engineering has received a preliminary approval to hire eight new faculty members in winter 2022. These new faculty members will support the AISE program (e.g., introducing relevant engineering AI-based technical courses).</p> <p>Faculty: The reviewers may have been confused regarding the number of technical electives available to the AISE students. In addition to AISE technical electives, as Dr. Shami explains, each Department will have their own technical electives on AI subjects relevant to their respective fields. Although they will have different subject identifiers (CBE, CEE, ECE, or MME), they are aimed at AISE students.</p>

<p>Vision and Image Processing, Machine Learning for Signal Processing, etc.</p>	<p>Recommendation 5*: Develop detailed program maps specific to each of the involved Engineering programs for students to follow. The program has a complex structure and to be successfully implemented such program maps would help students find their path.</p> <p>Program: All Western Engineering departments have developed and formally approved their respective concurrent degree engineering program with AISE program. Each engineering program with a concurrent degree with the AISE program, a detailed program map (i.e., program progression sheet) is approved by the Program Undergraduate Curriculum committee, Department Council, and the Faculty of Engineering Undergraduate committee. Western Engineering keeps up-to-date progression sheets for all programs at https://www.eng.uwo.ca/electrical/undergraduate/Current-Students/Program-Progression-Sheets.html. Once approved, the program progression sheets of all concurrent degrees with the AISE program will be added.</p> <p>Faculty: In agreement with program response.</p>
<p>Recommendation 6: Expedite the hiring process of faculty members and the needed technical and administrative support for the program. And hire faculty members with expertise in AI/ML applications specific to the core Engineering fields offered by the Faculty.</p>	<p>Program: a) The ECE department recruited four new faculty members with AI expertise in late Fall 2021. In addition, Western Engineering has received a preliminary approval from the University to hire eight new faculty members in winter 2022. These new faculty members will support the AISE program (e.g., introducing relevant engineering AI-based technical courses). The University has committed 25+ new faculty members to support the AISE program. b) The AISE program committee agrees that the AISE program has a complex structure and requires strong administrative and academic support. The program committee will actively work with the Faculty to hire a new Undergraduate Coordinator to support the program. c) The AISE program committee agrees that the state-of-art and best practices in AI are evolving rapidly, thus, a dedicated technical lab staff member (Lab Technologist) is required to help setup and update the AI laboratory environment and to support students and faculty members in this program. The program committee will actively work with the Faculty to hire a new lab technologist to support the program.</p> <p>Faculty: In agreement with program response.</p>

Implementation Plan

The Implementation Plan provides a summary of the recommendations that require action and/or follow-up. The Program Director, in consultation with the Associate Dean and Dean of the Faculty of Engineering, will be responsible for enacting and monitoring the actions outlined in Implementation Plan. The details of progress made will be presented in the Deans' Annual Report and filed in the Office of the Vice-Provost (Academic Programs).

Reviewer recommendations related to hiring are not typically prioritized in the implementation plan as they are outside the scope of the review. The number of recommendations prioritized for implementation has been reduced given that several have already been implemented, as explained in the summary of program and faculty responses.

Recommendation	Proposed Action and Follow-up	Responsibility	Timeline
<p>Recommendation 5: Develop detailed program maps specific to each of the involved Engineering programs for students to follow.</p>	<p>Upon approval of the program by Senate, develop program progression sheets for all concurrent degrees with the AISE program.</p>	<p>AISE program committee Supported by: the Program Undergraduate Curriculum committee, Department Council, and the Faculty of Engineering Undergraduate committee</p>	<p>By June 2022</p>