Final Assessment Report

Systems Design Engineering (MASc, MEng, PhD)

November 2025

Executive Summary

External reviewers were invited to review the Systems Design Engineering (MASc, MEng, PhD) programs delivered by the Department of Systems Design Engineering.

"Overall, the reviewers found the Systems Design Engineering Graduate Program to be a program with considerable strengths marked by the following: a) unique, inter-disciplinary program with international reputation, b) good set of instructional and research activities, c) dedicated graduate program staff, d) strong departmental leadership, and e) collegial graduate community environment, which has nourished work, study, and growth."

A total of five recommendations were provided by the reviewers, regarding program articulation, graduate course offerings, peer comparisons and assessment, an external advisory board, and the new Biomedical Engineering program. In response, the program created a plan outlining the specific actions proposed to address each recommendation as well as a timeline for implementation. The next cyclical review for this program is scheduled for 2028-2029.

Enrollment over the past three years

	MASc	MEng	PhD
2024-2025 (CURRENT YR)	84	87	100
2023-2024 (LAST YR)	93	89	107
2022-2023 (THREE YRS)	95	93	113

*Based on Active Student extract from Quest on November 13, 2025.

Background

In accordance with the University of Waterloo's Institutional Quality Assurance Process (IQAP), this final assessment report provides a synthesis of the external evaluation and the internal response of the Systems Design Engineering graduate programs (MASc, MEng, PhD delivered by the Department of Systems Design Engineering. A self-study (Volume I, II, III) was submitted to

the Associate Vice-President, Graduate Studies and Postdoctoral Affairs on October 11, 2023. The self-study (Volume I) presented the program descriptions and learning outcomes, an analytical assessment of the programs, including the data collected from a student survey, along with the standard data package prepared by the Office of Institutional Analysis & Planning (IAP). The CVs for each faculty member with a key role in the delivery of the program(s) were included in Volume II of the self-study.

From Volume III, two arm's-length external reviewers were selected by the Associate Vice-President, Graduate Studies and Postdoctoral Affairs: Professor Balakumar Balachandran, Department of Mechanical Engineering, University of Maryland, USA; and Professor Kamran Behdinan, Department of Mechanical Engineering, University of Toronto.

Reviewers appraised the self-study documentation and conducted a site visit to the University on September 30 - October 1, 2024. An internal reviewer from the University of Waterloo, Professor Robert Park, Department of Anthropology, was selected to accompany the external reviewers. The visit included interviews with the Vice-President, Academic & Provost; Associate Vice-President, Graduate Studies and Postdoctoral Affairs; Dean of the Faculty of Engineering; Faculty Associate Dean of Graduate Studies; Chair of the Department, as well as faculty members, staff and current graduate students. The Review Team also had an opportunity to visit the undergraduate facilities and meet with representatives from the library.

Following the site visit, the external reviewers submitted a report on their findings, with recommendations. Subsequently, the program responded to each recommendation and outlined a plan for implementation of the recommendations. Finally, the Dean responded to the external reviewers' recommendations, and endorsed the plans outlined by the program.

This final assessment report is based on information extracted, in many cases verbatim, from the self-study, the external reviewers' report, the program response and the Dean's response.

Program Characteristics

SYDE offers the following graduate programs:

- **Masters of Engineering (MEng) in Systems Design Engineering**
    - Course work: eight courses
- **Masters of Engineering (MEng) in Systems Design Engineering with specialization in:**
    (1) Artificial Intelligence and Machine Learning
    (2) Biomedical Systems
    (3) Human Factors

(4) Mechatronics and Physical Systems
(5) Vision, Image and Signal Processing
    - Course work: eight courses with four required in the specialization
- **Masters of Applied Science (MASc) in Systems Design Engineering**
    - Course work (a minimum of four courses) and a Thesis
- **Masters of Applied Science (MASc) in Systems Design Engineering - Nanotechnology**
    - Course work (a minimum of five courses) and a Thesis in the area of Nanotechnology
- **Doctor of Philosophy (PhD) in Systems Design Engineering**
    - Course work (a minimum of three courses) and a Thesis
- **Doctor of Philosophy (PhD) in Systems Design Engineering - Nanotechnology**
    - Course work (a minimum of four courses) and a Thesis in the area of Nanotechnology

The objective of SYDE's MEng degree program is to enhance trainee knowledge and expertise in either a broad range of topics related to systems design engineering or in a topic relevant to a specific industry, leading to one of the five specializations listed above. This program normally leads to more specialized employment in industry rather than a PhD program.

The objective of the MASc degree program is to provide students with specialized in-depth training that enhances their ability to do research in a systems-focused field. This degree can act as a step toward a PhD degree program or advancing career opportunities, both research or non-research, in industry or the public sector.

The primary objective of the PhD program is to train candidates to carry out independent original research in a chosen field. PhD students are expected to make significant research contributions to the body of knowledge that have scientific and/or socioeconomic impact.

<u>SYDE trains MASc and PhD students in the following research fields:</u>

- **Biomedical Engineering:** This field spans a spectrum of basic research areas including biomechanics, biomaterials, biosignal processing, medical imaging, and neuroscience. Applied research areas include physical ergonomics, assistive technology, rehabilitation engineering, sports engineering, neural engineering, brain-computer interaction, biodevice engineering, and biomedical measurement and instrumentation.
- **Human Factors and Ergonomics:** This field includes cognitive ergonomics, human-computer interaction, interface design, usability testing, visualization, and instrument design. Methods and areas of application include cognitive work analysis, graphical

interfaces for power plant control, broadband network management, usability of interactive technology, transportation safety, virtual environments, and detection and analysis of clinical data from medicine and health care.

- **Machine Learning and Intelligence:** SYDE has been internationally recognized as a world leader in this research field, which develops new theories and methodologies to enable the building of "intelligent systems." Research areas include machine learning, computer vision, pattern recognition, knowledge synthesis and representation, soft computing, sensor-based robotics, control of flexible robots, intelligent control, and multi-agent systems.
- **Mechatronic and Physical Systems:** Researchers in this field develop theories for mathematical modelling, analysis, simulation, and design of a wide variety of engineering systems. Essential concepts and tools from linear and nonlinear system theory, graph theory, stability theory, and computer techniques are foundational. Current areas of interest include vibrations, stability theories, large-scale systems, continuum systems, micro- and nano-electromechanical systems, acoustics, and photo-acoustics.
- **Modelling, Simulation, and Systems Theory:** This field includes a broad range of interdisciplinary areas centred on engineering design. Current research areas include time series modelling, energy modelling, spatial analysis, finite element methods, computer simulation of systems, reliability-based design, and network models for computer-aided design.
- **Optimization and Decision Making:** Areas of concern include bond-graph theory, design optimization, large sparse solvers, linear graph theory, non-linear systems, optimization, and surface model optimization.
- **Societal and Environmental Systems:** This field studies the dynamics of processes that involve people and their environment, such as water, travel and transportation, energy, housing and systems impacting and impacted by global climate change. Research areas include simulation, decision support; conflict analysis; impact assessment; optimization; and society, technology, and values.
- **Vision, Image, and Signal Processing:** This field is concerned with the acquisition, representation, presentation, and interpretation of data for purposes of communication and machine perception. Images are of principal interest, with applications in remote sensing, medical imaging, and computer vision. Image (structure and texture) analysis,

image coding, and vision models are primary areas of research activity, but speech and biological signal processing, and synthesis and classification also garner attention.

In collaboration with the Departments of Chemistry, Physics & Astronomy, Chemical Engineering, Electrical & Computer Engineering, and Mechanical & Mechatronics Engineering, SYDE also offers research-based MASc and PhD degrees in Systems Design Engineering - Nanotechnology for students focusing on nanotechnology applications to one of its eight research fields.

Summary of Strengths, Challenges and Weaknesses based on Self-Study

Strengths

- Our continued emphasis on interdisciplinarity, continued engagement with a multitude of partners in academia and industry in the province, across Canada, and worldwide.
- Our faculty are highly accomplished, and our graduates are well regarded, as can be seen from their ability to attract research funding and publish academic research as well as the awards they receive for their research and studies, respectively.
- Expansion of our program into biomedical engineering has allowed us to expand our faculty, staff, and student complements while continuing to emphasize quality.
- Successful expansion of our graduate programs to include a professional, MEng program and the introduction of specialization to emphasize our graduates' market readiness.

Challenges

- Financial support for MASc students has remained unchanged, throughout the reporting period while tuition and living costs have continued to increase. Further the University's elimination of the financial support it previously extended to international students under the IMAE program has resulted in a situation where the minimum support for international MASc is significantly less than their tuition, let alone any other costs! This puts us at a competitive disadvantage with other Canadian and international universities.

Weaknesses

- While the number of graduate courses has increased in the last three years, the availability, predictability, and distribution of graduate courses over the academic year are continuing challenges.
- The ability to retain our own undergraduate students for MASc and MEng as well as the ability to retain our MASc graduates and to attract other high-quality students to our PhD programs are continuing challenges.
- The need to engage our students and faculty to form an integral academic community engaged in learning on an ongoing basis.

Summary of Key Findings from the External Reviewers

"Overall, the reviewers found the Systems Design Engineering Graduate Program to be a program with considerable strengths marked by the following: a) unique, inter-disciplinary program with international reputation, b) good set of instructional and research activities, c) dedicated graduate program staff, d) strong departmental leadership, and e) collegial graduate community environment, which has nourished work, study, and growth.

The challenges include the following: a) clear articulation of what systems design engineering means to different stakeholders, b) in the context of the five identified research areas, streamlining of courses and connecting them to learning outcomes, c) lack of centralized recruiting office for graduate admissions, and d) transition to a graduate program with a Ph.D. program in Biomedical Engineering. The weaknesses include the following: a) graduate office staffing not commensurate with the needs of the program, b) lack of an external advisory board with industrial participation, and c) lack of graduate course offerings on a regular frequency for students to plan and take graduate courses."

External Reviewers' Recommendations and Program/Dean Reponses

1. **Program Articulation:** Continue to work on providing a clear articulation of what systems design engineering means to different stakeholders.

   Program Response

   The Systems Design Engineering graduate team is aligned with the undergraduate curriculum committee's definition of systems design engineering:

"A multidisciplinary program that integrates engineering, design and human factors to create innovative solutions to complex problems. This program is designed to develop engineers who can think holistically, considering the interactions between various system components, and who are equipped to work in diverse fields ranging from robotics and biomedical engineering to environmental systems and artificial intelligence. Central to the program is the emphasis on design."

We will work on the re-design materials defining how systems design thinking, human-centered design and interdisciplinary engineering create a distinguisher within all program elements with all stakeholders:
a) articulation during recruitment including materials outreach events;
b) systems thinking workshops and seminar discussions for current students;
c) systems design frameworks for supervisors; and
d) explicit articulation with alumni, industry partners and funders especially through the new industry advisory committee.

Dean's Response
I support the department's proposed actions to address this recommendation.

2. **Graduate Course Offerings:** Streamline graduate course offerings and connect them to learning outcomes. Establish a systems design engineering spline in the graduate curriculum. Suggest that the minimum number of courses for the Ph.D. program be four, for consistency across the different engineering programs as well as to provide students a foundational systems design engineering education. Form a task force comprising members from the University of Waterloo and experts from outside with regard to these efforts.

Program Response
In response, the SYDE graduate program committee recently updated the requirements for MASc and PhD degrees so that all research students will be required to complete at least one core course that establishes a background deemed directly applicable to the study of systems design engineering. While we are interested in further considering the content of these courses and the potential of designing more core content targeted toward research students in the future, we are first focused on expanding and stabilizing our course offerings and ensuring that existing courses are available on a reliable basis. Prior to the review, the committee had overseen the development of new core courses for our research programs. These new core courses have recently been added to the graduate calendar as a requirement. The focus will first be on providing reliable offerings of our pre-existing courses. We note for

the reviewers, that SYDE 620 (Fundamentals of Discrete and Continuous System Models) and SYDE640 (Experimental Design) were offered in Fall 2024 had good enrollment and were well-received. We will also attempt to expand the number of SYDE graduate courses as new faculty are hired.

The SYDE graduate committee debated the pros and cons of increasing the number of courses for PhD students. While some members of the department leadership support the increase in courses, the majority of faculty surveyed have identified that 3 courses is about right. In 2026, we will strike a sub-committee to study this matter further, identifying other institutions and programs with more than three course requirements to understand the pros and cons and communicate this information with the SYDE faculty and grad committee for further discussions about course requirements.

Dean's Response
I support the department's proposed actions to address this recommendation.

3. **Peer Comparisons and Assessment:** Make peer comparisons and assessments relative to other programs. While the choice of peers may not be easy, given the unique nature of the SYDE program, there could be overlaps with other local and international programs housed in the Departments of Industrial Engineering, Computer Science, and so on. These comparisons and assessments can help enhance and distinguish the program.

Program Response
To strengthen our program enhancement, we have agreed to identify three departments per research field in Canada and three departments per research field outside of Canada to conduct an in-depth comparison and analysis of our program. The input will provide national benchmarks, establish meaningful international comparators to allow for in-depth qualitative and quantitative analysis that remains manageable in scope while still capturing diversity and ensuring focus and depth. This review will help prioritize changes for program structure adjustments and incorporate peer assessments into learning outcomes and competency frameworks.

Dean's Response
I support the department's proposed actions to address this recommendation.

4. **External Advisory Board:** Establish an external advisory board with members from industry. This would be valuable for the program to seek inputs on their curriculum from different stakeholders as well as to bring support to the program and identify opportunities for students.

   Program Response
   We agree and are interested in including SYDE graduate alumni in a group of advisors. They will help to identify student needs and allow us to strengthen our program identity further. They will meet annually for the SYDE Graduate Student Symposium. After the symposium, their reflections and input will be sought in a meeting that includes the SYDE graduate program committee, Associate Chair, and Chair.

   Dean's Response
   I support the department's proposed actions to address this recommendation.

5. **BME Graduate Program:** Need to plan the evolution of this program so that the transition is seamless for the Systems Design Engineering Program as well as for other activities and programs in the Health Sciences area and other relevant areas on Campus.

   Program Response
   The BME Graduate Program is a newly established program that has undergone its own program review process, including a program proposal submitted to the Ontario Universities Council on Quality Assurance in 2023 and a site visit with both external and internal reviewers in early 2024. It is awaiting final approval from the Ministry of Colleges and Universities (MCU) before accepting transfer students from within UW, and it is currently accepting applications from new students for Fall 2025.

   This program has been established as a joint collaboration between Systems Design Engineering, Electrical and Computer Engineering, and Mechanical and Mechatronics Engineering, and has a complete plan to be independent of the SYDE graduate program. The BME graduate program has its own program director, and its first full-time staff member is now in place and is beginning to assess events and other needs for the program. The Biomedical Engineering program will run programming, unique to its own students, and has a separate graduate committee comprised of members from these departments and other relevant departments in the university.

Plans are in place to hire a PACE module coordinator to get the professional development aspects of the program up and running. This programming will include events such as a regular seminar series, research days, and site visits.

Dean's Response
I support the department's proposed actions to address this recommendation.

Recommendations Not Selected for Implementation

Recommendation 5: The BME program is already undergoing separate review and planning.

Implementation Plan

	Recommendations	Proposed Actions	Responsibility for Leading and Resourcing (if applicable) the Actions	Timeline for addressing Recommendations
1.	**Program Articulation:** Continue to work on providing a clear articulation of what systems design engineering means to different stakeholders.	Work on the program description communication re-design and articulation including updates to departmental website content, promotional and recruitment materials, informational session and how we visually and narratively present systems design engineering across our platforms.	SYDE Graduate Committee	Already underway (internal faculty consultation launched) Draft revised articulation by April 2026 Thesis/abstract guidelines approved by department by June 2026
2.	**Graduate Course Offerings:** Streamline graduate course offerings and connect them to learning outcomes.	Stabilize our course offerings to ensure that preexisting courses are available on a reliable basis & Strike a sub-committee to study if additional course for PhD students is needed.	SYDE Graduate Committee	Internal course-mapping work to commence in January 2026 Complete course-mapping and identify annual core courses by August 2026 Recommendation of PhD course (if needed) by October 2026 Finalize course plan by January 2027
3.	**Peer Comparisons and Assessment:** Make peer comparisons and assessments relative to other programs.	Identify three departments per research field in Canada and three departments per research field outside of Canada for comparison and analysis.	SYDE Graduate Committee	March 2026 (after internal consultation findings are compiled) Identify a longlist of

				potential peers by May 2026 Final 3 + 3 peers selected per field by July 2026 Prepare summary analysis by November 2026
4.	**External Advisory Board:** Establish an external advisory board with members from industry.	Include SYDE graduate alumni in a group of advisors meeting annually with the SYDE graduate program committee, Associate Chair, and Chair.	SYDE Graduate Committee	February 2026 (Chair to begin outreach and planning) Identify potential members and invitees by June 2026 finalize board membership by September 2026 First Advisory Meeting by November 2026 Board fully operational by December 2026
5.	**BME Graduate Program**	Not selected for implementation	NA	NA

The Department Chair/Director, in consultation with the Dean of the Faculty shall be responsible for the Implementation Plan.

Date of next program review 2028-2029

Date

Signatures of Approval

Please keep this document in Word version. We do require you to sign it or demonstrate your approval. If you have issues with signing a Word document, please confirm your approval by adding the following wording when you send back the document by email "I hereby approve the attached document." We will collect formal signatures at a later stage on a pdf version.

Lisa Aultman-Hall Digitally signed by Lisa Aultman-Hall Date: 2026.02.27 09:36:46 -05'00'

Chair/Director Date

AFIW Administrative Dean/Head (*For AFIW programs only*) Date

Mary A. Wells Digitally signed by Mary A. Wells Date: 2026.02.27 09:50:41 -05'00'

Faculty Dean Date

Note: AFIW programs fall under the Faculty of ARTS; however, the Dean does not have fiscal control nor authority over staffing and administration of the program.

Justin Khan

August 27, 2025

Associate Vice-President, Graduate Studies and Postdoctoral Affairs Date
(For graduate and augmented programs)