FINAL ASSESSMENT REPORT

PERIODIC PROGRAM REVIEW (PPR)
Bachelor of Engineering
In Computer Engineering
Faculty of Engineering and Architectural Science

In accordance with the Institutional Quality Assurance Process (IQAP)**,** this final assessment report provides a synthesis of the external evaluation and the internal response and assessments of the undergraduate **Computer Engineering** program. The report identifies the significant strengths of the program, together with opportunities for program improvement and enhancement, and it sets out and prioritizes the recommendations that have been selected for implementation.

The Implementation Plan identifies who will be responsible for leading the implementation of the recommendations; who will be responsible for providing any resources entailed by those recommendations; and timelines for acting on and monitoring the implementation of the recommendations.

SUMMARY OF THE PERIODIC PROGRAM REVIEW OF THE COMPUTER ENGINEERING PROGRAM

The Computer Engineering (COE) program submitted a self-study report to the Vice-Provost Academic on January 28, 2019. The self-study presented the program description and learning outcomes, an analytical assessment of the program, and program data including the data collected from a student survey along with the standard University Planning data tables. Appended were the course outlines for all core required and elective courses in the program and the CVs for all faculty members in the Department of COE and other faculty who have recently taught core courses (required and/or elective).

One arm's-length external reviewer, Dr. Michael Greenspan, Department of Electrical & Computer Engineering at Queen's University, and one internal reviewer, Dr. Ali Miri, Department of Computer Science at Ryerson University, were appointed by the Dean of the Faculty of Engineering and Architectural Science from a set of proposed reviewers. They reviewed the self-study documentation and then conducted a site visit at Ryerson University on May 21 and 22, 2019.

The visit included meetings with the Provost and Vice-President Academic; Vice-Provost Academic; Dean, Faculty of Engineering and Architectural Science; Chair, Electrical, Computer and Biomedical Engineering; and the COE Program Director. The Peer Review Team (PRT) also met with several members of the COE program within the Department of Electrical, Computer and Biomedical Engineering, including staff, students, and faculty members. A general tour of the campus was provided, including a tour of the program facilities, labs, classrooms, and the library.

In their report, dated August 8, 2019, the PRT provided feedback that describes how the COE program meets the IQAP evaluation criteria and is consistent with the University's mission and academic priorities. The PRT also noted faculty's strong SRC record, and the rich innovation ecosystem provided to its students through opportunities such as Zone learning, the Co-operative Internship Program, and various professional societies.

The main areas of strength identified by the PRT include:

- The leadership in the program. This is both at the faculty level (Department Head), technical engineering

staff (Lead Engineer), and is also evidenced in the administrative staff.

- With a few exceptions, the program is extremely diverse, as evidenced by the large number of students and faculty who identify as visible minorities. This is an earmark of the technical area, and while not unique to Ryerson, it nevertheless presents as an area of strength of the program, and results in a culture of inclusivity, which should be recognized and celebrated.

The PRT also identified areas for improvement. The exceptions to the otherwise diverse culture of the program are in the area of gender, and aboriginal representation. These are again endemic and not distinct to Ryerson. There is also the opportunity to develop a technical focus on the area of Artificial Intelligence and Machine Learning (Al/ML).

The Chair of the Electrical, Computer, and Biomedical Engineering program submitted a response to the PRT Report on November November 18, 2019. The response to both the PRT Report and the Program's Response was submitted to the Vice-Provost Academic by the Dean of the Faculty of Engineering and Architectural Science on November 23, 2020.

The Academic Standards Committee completed its assessment of the Computer Engineering Program Review on February 4, 2021**.** The Committee indicated that a thorough, analytical and self-critical program review was conducted. The School integrated into the developmental plan feedback from students, alumni, employers and peer reviewers, and outlined a comprehensive plan for program enhancements moving forward.

The Academic Standards Committee recommends that the program continue, as well as provide a one-year follow-up report by June 30, 2022**,** as follows:

1. Updates on the status of the initiatives outlined in the Implementation Plan;
2. An expanded version of Learning Outcomes with sub-categories that fall under each of the main categories;
3. Results of an up-to-date employer Survey.

Presented to Senate for Approval: **March 3, 2021**

Start date of next Periodic Program Review: **2023-24**

SUMMARY OF THE REVIEWERS' RECOMMENDATIONS WITH THE PROGRAM'S AND DEAN'S RESPONSES

RECOMMENDATION 1. Introduce Software Engineering option/program. The addition of a Software Engineering program would be extremely beneficial to Ryerson's educational landscape.
Department's Response: We have made significant progress in creating a software engineering option within the computer engineering program. Extensive discussion has been conducted with the department of Computer Science on this issue during the spring and summer of 2019 and an agreement has been reached with Computer Science for them to deliver 3 of the 7 new courses that is required to establish the option. The proposal for the option was approved unanimously by Ryerson Senate on November 3, 2019.
Dean's Response: The Department has launched a Software Engineering option commencing in Fall 2020 after the unanimous approval by Ryerson's Senate on November 3, 2019. The Software Engineering option includes several new technical electives.

RECOMMENDATION 2. Update and Refresh early core circuit course ELE 202 & ELE 302 laboratory experience. The laboratory experiments have not been changed or updated for a very long time and the lecture content is

not in synch with lectures.
Department's Response: This issue was identified in student survey. Students struggle with the laboratory experiments when lecture content is not in synch with lab experiment content, when experiments are considered "too long" to be done in the allotted time, and when TAs are not trained enough to be able to help students in the lab. Our intention is to change lab experiments completely and provide increased and improved training for TAs.
Dean's Response: no response.

RECOMMENDATION 3. Create common lab courses, or "lower years engineering design projects", where semester-long or year-long extended lab projects will support multiple courses.
Department's Response: As is mentioned by the reviewers, creating a common undergraduate lab that covers a number of courses (rather than a specific lab for each course) is a challenging task. We have had some initial discussions on how a curriculum structure such as this could work but we are still at a very early stage and do not expect any changes in this regard in the next 5 years.
Dean's Response: Creating a common undergraduate lab that covers a number of courses (rather than a specific lab for each course) is a challenging task. The Department continues to have discussions about this and other major curriculum restructuring options but these discussions are not set to impact the structure of the current program for another 5+ years.

RECOMMENDATION 4. Fourth year professional electives need to be evaluated for currency, program need and student interest. It is sometimes difficult to gauge student interest, which can change over time. One method that has been effective is to allow a large number of upper-year electives, and then only offer those which are significantly enrolled. This allows the students to vote with their feet, and provides flexibility and a natural source of feedback to continuously evolve the palette of elective courses, which can otherwise become mired it faculty preference and stale.
Department's Response: We have already begun discussions as to which courses need to be removed, updated and which topics need to be introduced via new courses. For example, ELE 401 Field Theory, which is an Electrical Engineering fundamentals course, has been replaced with COE 501 Electromagnetism: Theory and Effects, a course that will be geared to COE students. Furthermore, the Software Engineering option has been approved and with it new 4th year electives are going to be made available to students. Moreover, we are also hiring another faculty member in the Machine Learning/Artificial Intelligence domain to help augment our program in this respect.
Dean's Response: In the final year of the program, students take courses in data communications, digital systems engineering, real-time operating systems, VLSI design, and capstone design. The fourth year curriculum also allows students further specialization in a variety of subject areas through an extensive technical electives list. During this final year of the program all students must complete a mandatory group design project. The key objective of the design project is to encourage students to plan, design and implement their project while developing the skills to make key decisions independently.
The department has already begun restructuring course offerings. With respect to technical electives, the Department is also discussing which courses need to be removed, updated, and which topics need to be introduced via new courses. The Department has hired another faculty member in the area of machine learning/artificial intelligence to help augment the program in this respect.

RECOMMENDATION 5. Improve TA support to undergraduate courses with overall increased stringency on the requirements for selection and also with adequate training and preparation. At most universities, upper-year undergraduates have been recruited to serve as TAs for lower-year lab courses. For example, a set of third-year students serve as TAs for a second-year course, which they took themselves the previous year. This has a number of benefits, the most prominent being that the undergraduate students relate very well to each other,

and there are a relatively large pool of them. Graduate TAs are used primarily for tutorials and grading.
Department's Response: Allowing upper year (4th year) undergraduate students the opportunity to be TAs for lower year courses is an idea that we are currently discussing. Not only will this help lower-year students by providing a peer as a mentor but will also provide leadership and life-long learning skills to the upper-year students.
Dean's Response: no response.

RECOMMENDATION 6. Integrate opportunities for students to improve and build on soft skills (e.g., leadership, oral presentation, professionalism).
Department's Response: Our student survey identified skill areas that are not well addressed. Soft skills are not a formal part of the engineering curriculum but they are essential skills for a professional engineering in industry. We intend to introduce more oral presentations, particularly in 2nd and 3rd year, while also providing avenues to cultivate leadership skills.
Dean's Response: no response.

RECOMMENDATION 7. Increase the number of co-op internship jobs available to students. Interfacing with companies to develop meaningful and long-term internship opportunities is a time consuming and specialized skill. To do this correctly, it would be beneficial to have additional dedicated (and high level) administrative support.
Department's Response: The department realizes that the front office is somewhat lean. To that end, the Dean of FEAS has approved the hiring of one additional Departmental Assistant (approved for 1 year currently), to help with the front office load. This position has currently been filled as of November 11, 2019. Hopefully this position will become permanent.
Dean's Response: A new Departmental Assistant position was recently created to help with the front office load. In late 2017, FEAS launched a central office to manage optional co-operative internship programs (CIP) for all of the engineering programs except Chemical Engineering which has a mandatory co-operative program. Since this time, the team has grown from 1 staff member to 5. This team collaborates with existing embedded staff within departments (including ECBE) to support all aspects of CIP including new on-line platforms (Salesforce and Orbis) for efficient student and employer engagement related to applications, job postings, etc; student and employer recruitment events and workshops; administration and evaluation of the placement experiences; and delivery of soft skill development modules associated with career readiness and professional networking. In Fall 2019, the FEAS CIP office rolled out the first centralized student enrolment in FEAS CIP.
The FEAS CIP office is continuing to work on improving the co-op placement rate of computer and other engineering students through the following activities: 1) identifying and working closely with students who are less engaged (i.e. do not apply to posted jobs, apply but do not secure interviews and/or job offers), 2) continuing to work with existing employers and promote jobs that are more relevant to specific engineering disciplines, 3) developing more partnerships with new employers/industries interested in specific engineering disciplines, aiming towards a 3 job postings to 1 student ratio, and 4) planning employer engagement events/opportunities that target specific engineering discipline students. We are reaching first and second year students to promote CIP earlier so that they are better prepared to meet the expectations set by the program and employers.

RECOMMENDATION 8: Hire new tenure-track faculty to augment program. Hiring new faculty should be a priority, as there is a window of opportunity to enhance the COE program, and the hiring landscape in this area is competitive.
Department's Response: From a faculty hiring point-of-view, the COE program hired two new female faculty members that started July 1, 2019.
Dean's Response: The faculty complement is sufficient for the current needs of the program but we will continue working to meet goals related to expertise, equity, diversity, and inclusion. As reported earlier, the Department

has hired another faculty member in the area of machine learning/artificial intelligence. Two new female faculty members in computer engineering joined the Department starting July 1, 2019.

IMPLEMENTATION PLAN

Priority Recommendation #1 *Introduce Software Engineering option/program.*

Rationale: *There is an increasing demand, in general, for computer engineers specializing in software engineering and their importance and marketability cannot be over-exaggerated. Our neighbouring institutions and most others across Canada have some form of Software Engineering within their COE programs. We are behind in this aspect and are doing a disservice to students in our program by not offering our own variant.*

Objective: *Develop an option of Software Engineering that could lead to a separate program.*

Implementation Actions:

- *Determine what a software engineering option would require in terms of courses*
- *Evaluate other programs and do a comparative analysis*
- *Identify which existing courses would be utilized*
- *Determine any additional courses*
- *Design any new courses*

Timeline: (What are the estimated timelines for acting on implementation of the recommendation?)
2018/19

- Determine requirements in terms of courses
- Design new courses that are needed
- Update any existing courses that can be utilized
- Submit for approvals

2019/20

- Start new Software engineering option

Responsibility for
a) leading initiative: *Program Director, Computer Stream, Curriculum Committee, Department Chair*
b) approving recommendation, providing resources, and overall monitoring: *Stream, Curriculum Committee, Departmental Council, Dean, Senate*

Priority Recommendation #2 *Update and Refresh early core circuit course ELE 202 & ELE 302 laboratory experience. The laboratory experiments have not been changed or updated for a very long time and the lecture content is not in synch with the lab experience.*

Rationale: *This issue was identified in the student survey.*
Students struggle with the laboratory experiments for the following reasons:

- *Lecture content is not in synch with lab experiment content and thus students feel lost*
- *Experiments are very time-consuming and considered "too long" to be done in the allotted time*
- *Many TAs are not trained enough to be able to help students in the lab*

Objective: *Change lab experiments completely and provide increased and improved training for TAs.*

Implementation Actions:

- *Design new experiments;*
- *Test experiments for difficulty and for reasonable time requirements for completion;*
- *Hire a "Lab Lead" to supervise Lab TAs and to provide additional support during lab supervision;*
- *Provide more preparation hours for all TAs to perform all labs before they supervise to ensure they are aware of what the students are required and expected to do;*
- *Have "Lab Lead" train TAs on lab supervision and on the actual lab experiments.*

Timeline:

ELE 302:

- *Summer 2018: design and test new labs*
- *Fall 2019: introduce new labs into course and sync lecture material*
- *Hire CUPE as Lab Lead*

ELE 202:

- *Winter 2019 Hire CUPE as Lab Lead*
- *Summer 2019: design and test new labs*
- *Winter 2020: introduce new labs into course and sync lecture material*

Responsibility for

a) leading initiative: *Course instructors*

b) approving recommendation, providing resources, and overall monitoring: *Department Chair*

Priority Recommendation #3 *Fourth year professional electives need to be evaluated for currency, program need and student interest.*

Rationale: *There are a relatively large number of 4th year professional electives, some of which have not run in the past few years due to low student demand or industrial relevance and some have become "stale".*

Implementation Actions:

- *Analyze enrollment data of all courses over the last 10 years;*
- *Identify courses that are essential;*
- *Identify courses whose content has not changed in the last 5 years and also those that have had very low student demand;*
- *Identify areas/topics that are currently in demand that we do not offer;*
- *Update "stale" courses*
- *Delete courses with historically low interest and/or currently irrelevant topics*
- *Introduce new courses covering topics in emerging and new areas (e.g. AI)*

Timeline:

- *2018/19: analyze enrollment data, identify courses for deletion/refresh, propose new courses*
- *2019/20: roll-out updated professional electives table*

Responsibility for

a) leading initiative: *Department Chair, Program Director, Curriculum Committee, Stream Committees*

b) approving recommendation, providing resources, and overall monitoring: *Stream, Curriculum Committee, Department Council, Dean*

Priority Recommendation #4 *Improve TA support to undergraduate courses with overall increased stringency on the requirements for selection, and with adequate training and preparation.*

Rationale: *Notwithstanding our efforts to select appropriate graduate students as teaching assistants in our labs, our recent surveys have indicated that there are courses where the TAs are not well prepared to assist students.*

Objective: *Provide more hours for increased and specialized training for TAs in core courses.*

Implementation Actions:

- *identify key courses that have a large number of TAs;*
- *increase preparation/training hours for TAs in those courses;*
- *require TAs to perform and complete all labs that undergraduate students will be doing;*
- *introduce and hire Lab Leads to roam labs and provide extra support and supervision.*

Timeline: *2018/19 academic year*

Responsibility for

a) leading initiative: *Department Chair*

b) approving recommendation, providing resources, and overall monitoring: *Department Chair*

Priority Recommendation #5 *Increase the number of co-op internship jobs available to students.*

Rationale: *Our internship program is proving to be very popular. In 2018/19 we will be having 80 students on internship, which is a record. Unfortunately, 60 students were not able to secure an internship position primarily due to an insufficient number of positions available.*

Objective: *Even though our co-op internship is "optional" and students must meet a minimum requirement, there is high demand in the last couple of years. Unfortunately, we have not been proactive to contact new employers for possible internship positions and have relied on our existing employers. With this increased demand we need more potential employers that can provide valid co-op internship jobs.*

Implementation Actions:

- *Identify potential employers in GTA and Southern Ontario*
- *Create 1-page prospectus/flyer that provides quick info on our co-op internship and benefits to the employer*
- *Plan site-visits with potential employers to discuss their participation*

Timeline:

Fall 2018

- *create prospectus/flyer;*
- *identify possible new employers;*
- *send out email and flyer*
- *follow up and initiate discussion;*

Winter 2019

- *continue constant contact with existing employers and continue identifying and inviting new employers.*

Responsibility for

a) leading initiative: *Department Chair, Program Director*

b) approving recommendation, providing resources, and overall monitoring: *Internship Co-ordinator, Program Director, Internship Admin, Department Chair*