Lakehead University

New Program Proposal Brief
for the
M.Sc. in Civil Engineering

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VOLUME I: The Program

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1. An Introduction & Rationale for the Proposed Program

1.1 Overview of the Home Unit

The Department of Civil Engineering wishes to establish its first graduate program in Civil Engineering. Currently, five out of its nine faculty members in this department participate in the existing MSc Eng in Environmental Engineering (established in 2004). The Faculty of Engineering is also pursuing the introduction of an MSc program in Mechanical Engineering and a new PhD program in Electrical and Computer Engineering will soon be offered. The proposed graduate program will lead to the degree of Master of Science (M.Sc.) in Civil Engineering and will be a thesis-based degree.

1.2 Objectives of the Program

The objectives of the proposed MSc are to develop research capabilities and offer advanced learning opportunities in the general area of Civil Engineering at Lakehead University. The program aims to attract students from the existing BEng program in Civil Engineering at Lakehead University and also attract qualified students from other Canadian and international universities. The specific objectives of the program are:

(a) to provide an opportunity for students to specialize in specific areas of Civil Engineering;
(b) to develop research and development engineers in the field of Civil Engineering for Industry;
(c) to provide practising engineers an opportunity to develop as researcher and contribute to engineering sciences;
(d) to lay a foundation for students to pursue doctoral studies in Civil Engineering and related disciplines;
(e) to foster the scholarly skills and independent research abilities of students in the program through advanced courses, doing research, writing theses and scientific papers, participating in seminars and an oral defence;
(f) to promote the research capabilities of the faculty members in Civil Engineering at Lakehead University; and
(g) to improve and expand research facilities at Lakehead University by attracting additional research funding.

Graduating students from the program are expected to specialize in sub-disciplines within Civil Engineering by taking advanced-level courses, reviewing and critically evaluating existing literature in specific research areas, conducting research and contributing to the advancement of engineering sciences in specific areas, preparing and presenting scholarly publications, and writing and defending a thesis. In addition, students will acquire skills to help them in academic careers by working as a teaching assistant in undergraduate courses and tutoring undergraduate student activities in laboratories.

1.3 Rationale for the Development of the New Program

The Department of Civil Engineering has seen tremendous enrolment growth in its undergraduate program in recent years (see Table 1 for statistics of B.Eng. degree awarded in the last nine years). The quality of its undergraduate program has been regularly affirmed by the Canadian Engineering Accreditation Board. The proposed MSc program is aligned with the University's priority stated in its 2012-2017 Academic Plan : *"Strong graduate programs are fundamental to advanced research and in many disciplines graduate students are essential components of the support structure for teaching and research activities."* In particular, the objectives of this MSc in Civil Engineering will be as follows:

(a) recruitment and retention of outstanding faculty members;
(b) attracting outstanding undergraduate students;
(c) attracting research funds from federal and provincial agencies and industrial sectors;
(d) support of Lakehead University's strategic research goals for the region and beyond;
(e) strengthening of the University's graduate programming and training of highly-qualified personnel;
(f) innovative research contributions to the region, the country and the world; and
(g) enhancing the quality of Civil undergraduate program through recruiting qualified graduate students as teaching assistants.

Five out of the nine faculty members in the Department of Civil Engineering participate in the interdisciplinary graduate program in Environmental Engineering. However, the diversity of research areas of the faculty members and the need for graduate students in their respective areas necessitate the establishment of the proposed program. The program will focus on emerging sectors such as Fire Engineering, Highway Safety, Pavement Management, as well as new research perspectives within Foundation Engineering, Water Resources, Structural Optimization, Steel and Reinforced Concrete Structures, Structural Analysis and Earthquake Engineering.

Table 1 – The number of B.Eng Degrees in Civil Engineering Awarded

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012
Number	43	29	53	66	51	66	73	98	86

Twenty-nine universities in Canada offer Civil Engineering program. Among them eleven are in Ontario (Carleton, Lakehead, McMaster, Ottawa, Queen's, Royal Military College of Canada, Ryerson, Toronto, Waterloo, Western Ontario, Windsor). Lakehead University is the only one in Ontario that does not have a graduate program in Civil Engineering.

1.4 Relationship between the Proposed MSc Program and the Available Graduate Programs

Currently there are three MSc graduate programs in the Faculty of Engineering: Control, Environmental, and Electrical and Computer Engineering. Five out of its nine faculty members in the Department of Civil Engineering participate in the interdisciplinary graduate program in Environmental Engineering. Unfortunately the Environmental graduate program is not attractive to the majority of our undergraduate students, with very few applications due to background limitations. After MSc graduate programs have been established in the related departments such as Mechanical, Civil, and Chemical Engineering, the status of the Environmental graduate program will be re-evaluated by the Faculty of Engineering based on comprehensive considerations related to program perspective and resource availability.

1.5 Program Demand

Civil engineering is one of the oldest engineering disciplines. It includes sub-disciplines such as environmental engineering, geotechnical engineering, structural engineering, transportation engineering, municipal engineering, water resources engineering and mining engineering. Civil engineering takes place on all levels: in the public sector from municipal through to national governments, and in the private sector from individual consulting practices through to international companies.

In recent years, as the Canadian Government saw infrastructure investment as an engine for economic growth, the job market for Civil Engineering graduates has been booming. In its latest job outlook report (release date: 2011-11-23 http://www.workingincanada.gc.ca/), the Government of Canada ranks the Employment Potentials and Trends for civil engineers in the provinces of Alberta, Newfoundland and Labrador, Ontario, and Quebec as GOOD. The following is an excerpt from the report on the employment trend in Ontario: “In Ontario, the outlook for civil engineers is expected to be good in 2011-2012. Demand for these professionals has been increasing due to the growth in public sector spending on infrastructure and an increase in private sector construction and energy projects. Increased demand in infrastructure, transportation and transit, and power transmission and distribution facilities to accommodate the needs of a growing population should contribute to the demand for civil engineers in most regions of Ontario. Although intermediate and senior level engineers will be in greater demand across Ontario, engineers with their Professional Engineer (P.Eng) Licence will be in higher demand in smaller cities and rural communities due to the limited supply of experienced engineers outside of metropolitan areas. Also, opportunities will be better for those who are willing to travel as many engineering firms work on projects in other areas. According to the 2006 census there were about 15,500 civil engineers in Ontario, a 6.5% increase from the previous census. The average age for civil engineers was 44; 4 years older than the provincial average for all occupations. In addition, almost one-third civil engineers in Ontario were 50 years and over in 2005. Job opportunities should arise from the need to replace retiring workers.”

In particular, the report includes the following remark on Northwest Ontario: “In the Northwest region, the outlook for civil engineers is expected to be good in 2011-2012. Exploration for minerals, large mining operations, and the creation of railroads and infrastructure to support these large operations will contribute to the demand for this occupation over the next few years. According to the 2006 census, Northwest Ontario had one of the smallest populations of civil engineers of all eleven Ontario economic regions, with just fewer than 230 people in this occupation. Firms in the region sometimes encounter difficulty attracting new graduates and keeping senior engineers due to strong demand in metropolitan areas.”

According to *Canadian Engineers for Tomorrow: Trends in Engineering Enrolment and Degrees Awarded 2006-2010* published by Engineers Canada, the undergraduate enrolment in civil engineering has shown the strongest gains since 2006 relative to the other engineering programs. There were 10,604 full-time students reported for 2010 nationwide, a 10.3 percent increase from the previous year, and a striking 42.9 percent increase from 2006.

The construction industry has long recognized the need to have a work-force that is creative and capable of conducting cutting-edge research to keep it competitive in a global environment. An advanced degree in Civil Engineering helps address this need. Furthermore, the civil discipline itself, while maintaining its traditional roots, has evolved to include new and emerging areas such as fire safety, structural resistance to abnormal loading (e.g., scenario of column failure caused by terrorist attack), global warming impact on environment, infrastructure health monitoring and repairing, and sustainable development. Consequently, graduates from Civil Engineering often feel the need to upgrade their qualifications to keep up with rapidly changing technologies. The growing demand for post-graduate programs is evident in the following data reported by Engineers Canada (report title: Canadian Engineers for Tomorrow: TRENDS IN ENGINEERING ENROLMENT AND DEGREES AWARDED 2006-2010):

21,083 graduate students enrolled in master’s or doctoral programs in engineering across Canada in 2010, a growth of 9.8 percent compared to 2009. This rise was led by both master’s and doctoral enrolments, with an increase of 9.8 percent and 9.7 percent respectively. In contrast, master’s and doctoral enrolments grew by 2.5 percent and 5.2 percent respectively the year prior. For master’s programs in civil engineering, the enrolment in 2010 was 1,852, a growth of 4.3 percent compared to 2009.

2,565 enrolled as part-time master’s students in 2010, an increase of 2.4 percent from 2009. Full-time master’s enrolment grew at a faster rate in comparison to past years, increasing by 11.7 percent in 2010, whereas in 2009 and 2008, the increase was only 0.8 percent and 2 percent respectively.

The aforementioned data shows that the ratio of student populations in civil engineering between master degree and undergraduate in 2010 is 0.17 (i.e., 1852 to 10604) nationwide. Lakehead University had 292 civil engineering undergraduate students in 2010 (data provided by the Office of Institutional Analysis), which implies a demand of enrollment of about 50 master degree students.

During the past 6 years, 17 Lakehead students went on with graduate programs in other universities, in addition, 6 students went on with the Lakehead Environmental MSc program.

Therefore, as the only Ontario university with no graduate program in Civil Engineering, Lakehead University must seize this growing opportunity to establish the new graduate program, MSc in Civil Engineering. The development of such a program would provide an opportunity for students in the region to pursue advanced studies, especially important due to the remote location of Lakehead University.

1.6 Degree Nomenclature

At Lakehead University, all the existing engineering master degree programs (including the newly developed master degree program in Mechanical Engineering) are called "Master of Science in Engineering". Thus, to be consistent with the practice, graduates from the proposed program will have the degree of “Master of Science in Civil Engineering”.

The related Master’s programs in most of the research universities in the USA are called MSc in Civil Engineering, such as M.I.T, Stanford University, and the University of California in Berkeley. In Canada, many universities call the degree "Master of Applied Science in Civil Engineering, or MASc" (for example, University of Toronto). Note that the name "Master of Engineering, or MEng" is not suitable for the proposed program, as it usually refers to a course-based graduate program, in which a student is normally expected to complete the program within one year (i.e., three consecutive terms) through doing a specified number of courses and a project. In general, little research work is involved in a MEng program. Thus, it can be said that MSc is a higher standard master degree.

The MEng program is usually tailored for those who want a "fast-track" master degree. But, since this type program demands much more teaching loads and generate little research output, it does not suit the current needs of the department. This proposal is only about establishing MSc program in Civil engineering.

The MSc in Civil Engineering is obtained through a combination of formal course work and thesis work. Graduates are expected to gain a broad knowledge in the fields related to the program by taking graduate courses, mentoring undergraduate students, and leading laboratory sessions. Research skills are also acquired by reviewing the literature, conducting research, writing a thesis, and presenting research results.

Graduate students in the program are required to:
(a) complete the required course work;
(b) conduct independent research;
(c) present a research seminar;
(d) accomplish an oral defence; and
(e) report their research work in a thesis.

2. Program Learner Outcomes

2.1 Program Learner Outcomes (PLO)

After completing the MSc program, graduates will be able to:

(a) critically evaluate existing theories, analysis techniques and literature in selected Civil Engineering fields (for example, structural, geotechnical, water resources, environmental and transportation engineering).
(b) conduct independent research and show competence in the research process of a specific area within the general Civil Engineering fields using pertinent advanced mathematical, scientific, and engineering concepts.
(c) design and conduct experiments and/or analytical/numerical analyses, depending on the nature and scope of the thesis research.
(d) demonstrate originality in solutions to engineering problems through the use of analytical, computational and/or experimental techniques.
(e) treat and analyze complex issues based on established principles and techniques within the discipline of Civil Engineering.
(f) demonstrate personal responsibility and accountability and develop the capability to appreciate the broader implications of applying knowledge to particular contexts.
(g) communicate ideas, issues and conclusions clearly and effectively.
(h) recognize the complexity of knowledge through the course of research and potential contributions of other technologies.

2.2 Alignment of the Program Learner Outcomes with the University Degree Level Expectations

The aforementioned Program Learner Outcomes (PLO) of the proposed MSc in Civil Engineering will meet the Graduate Degree Level Expectations at Lakehead University:

(1) Depth and Breadth of Knowledge: They are related to item (a) of the PLOs. The literature review report(s), project seminar and thesis will ensure that the candidate has a systematic understanding of knowledge and an awareness of current problems in the chosen field of research. The candidate will perform a thorough and in-depth review of the knowledge in the field related to their research project. This review must show a solid understanding of the foundations of the area, and provide an overview of the latest developments.

(2) Research and Scholarship: They are related to items (b, c, d) of the PLOs. The MSc candidate will be capable of making a thorough evaluation of current research and scholarship in his/her research field. The candidate should be able to present a treatment of engineering problems based on established principles and techniques. The candidate's research and scholarly abilities will be reflected and evaluated in his/her thesis. The thesis will be evaluated by a thesis committee composed of professors with expertise in the research area.

(3) Level of Application of Knowledge: It is related to item (e) of the PLOs. By completing all the requirements of the program, the candidate will demonstrate a competency by applying an existing body of knowledge in the critical analysis of a new question or of a specific problem or issue in a new setting. The learning and problem-

solving skills that the candidates develop will allow them to undertake new academic and professional projects in different areas of Civil Engineering.

(4) Professional Capacity/Autonomy: It is related to item (f) of the PLOs. The candidate will learn and understand the importance of being systematic and disciplined in keeping records and applying objectivity in the evaluation of scientific results. By working with faculty members as mentors, candidates will engage in research and knowledge-transfer that will have continuity. They will learn both the importance of building upon others' work and of properly documenting their work so that others can build upon it. It is expected that graduates from the program will register as Professional Engineers and will abide by the association's code of professional conduct and ethics.

(5) Level of Communication Skills: It is related to item (g) of the PLOs. A successful MSc candidate is expected to present her/his work orally to a group of peers during course project presentations, the seminar and the final thesis defence. On these occasions, the candidate will be evaluated on her/his ability to provide a clear, complete and scientifically-accurate presentation of her/his research work and defend the results and conclusions to an audience of peers and experts constituting his/her thesis committee. In addition, MSc candidates will be encouraged to participate in conferences by giving oral presentations or poster sessions to present their research work.

(6) Awareness of Limits of Knowledge: It is related to item (h) of the PLOs. In the literature review in the thesis and in oral presentations, the candidate is expected to study and discuss the extent of knowledge in her/his area. This will create self-awareness of the potential limitations of the knowledge in their research area and possible future solutions.

3. Admission Requirements

3.1 A Summary of the Admission Requirements

Candidates are accepted under the Admission Requirements of the Faculty of Graduate Studies Master's Regulations, provided that the requirements of the Faculty of Engineering are also satisfied. Normal admission to an MSc in Civil Engineering requires a Bachelor's Degree in Civil Engineering (or other equivalent four-year programs), in addition to all other general admission requirements of the University.

An applicant to the program may be required to take additional make-up courses from the undergraduate program at Lakehead University if the student's background is assessed to be deficient in Civil Engineering.

3.2 Appropriateness of the Program's Admission Requirements for the Learning Outcomes Established for Completion of the Program

The stated admission requirement to the MSc in Civil Engineering (i.e., a four-year Bachelor's degree in Civil Engineering or closely related field from a recognized university, college or institute with at least 70% cumulative average or equivalent on the

last 20 half courses.) is necessary to guarantee the selected students will have the technical background and experience needed to take the advanced engineering courses and carry out research work in Civil Engineering and to meet the stated learner outcomes for the program.

The University's admission requirement for fluency in English will ensure that the candidate has the necessary communication skills to meet all requirements of the program and develop new skills to meet the learning outcomes of the program.

3.3 A Sufficient Explanation of Alternative Requirements

Credit for up to two half-courses may be given to candidates transferring from other Canadian universities. The Engineering Graduate Studies Committee will evaluate the suitability of courses for credit transfer.

4. Structure

4.1 Program Regulations and Requirements

The requirements for the MSc in Civil Engineering are:

(a) four half-courses, of which at least three must be chosen from the graduate courses in Civil Engineering;
(b) the graduate seminar;
(c) the graduate thesis.

The draft Calendar entry for the proposed program can be found in Appendix D and an extract of the current Calendar with general University Graduate Studies Regulations is provided in Appendix E.

4.2 Explanation for how the program's structure will result in students meeting the specified program learning outcomes and degree-level expectations. A discussion of the teaching component and what it provides the student

The structure of the proposed MSc program is designed to result in students meeting the specified Program Learning Outcomes as well as Degree Level Expectations.

The student begins the program by taking at least four half-credit courses, each of which is chosen in consultation with the supervisor. Three of the half-credit courses (one of them may be a reading course) will be the graduate courses in Civil Engineering. These courses will provide students with systematic understanding of knowledge in the related research fields in Civil Engineering, as well as advanced mathematical, scientific, and engineering concepts and tools to tackle general engineering problems. Each course has a set of carefully designated Student Learner Outcomes (SLOs) as listed in Appendix E, which are aligned to achieve the Program Learner Outcomes and Graduate Degree Level Expectations. During these courses, the student will develop skills and learn methodologies that are useful over the course of the

research work. The related course SLOs are assessed based on assignments, course project, project presentation, and examinations.

A student can take a half-credit senior undergraduate course under the approval of his/her supervisor and the graduate coordinator. The undergraduate course aims to provide the student supplementary background knowledge related to his/her research work. The course SLOs will be evaluated through assignments, course project and/or project presentation, and examinations.

The project seminar is the first major evaluation of the students' research work. It will allow the students to share what they have learned during their background review and research work, and to explain their proposed research methodologies to their committees. Another SLO of the seminar is to make sure the student can communicate ideas, issues and conclusions clearly and effectively. On the other hand, the student is required to attend seminars of his/her peers to get knowledge and problem-solving strategies in other research areas, and to learn critical thinking through asking and answering questions.

A student is required to do a literature survey, before beginning systematic research work, to critically evaluate existing literature in the related research field and demonstrate systematic understanding of knowledge with the required depth and breadth. The literature survey report(s) should be assessed by the supervisor.

A student is required to conduct independent research work, in consultation with his/her supervisor. The student will show competence in the research process and demonstrate advanced research and scholarship of a specific area. The student will design and conduct experiments and/or numerical simulations depending on the nature and scope of the thesis research, and develop novel solutions and demonstrate originality to engineering problems through the use of analytical, computational and/or experimental techniques.

The final component of the graduate curriculum is the production of a thesis and its oral presentation to the committee at an oral defence. The student must demonstrate the ability to communicate his/her research work, results and conclusions in clear, complete and scientifically accurate presentations to an audience of peers and the Committee.

4.3 Times-to-Completion

Students will enrol full-time in the program. The Faculty of Graduate Studies will consider requests for part-time registration. Graduate students registered part-time may not take more than one full course equivalent during an academic year. The graduate students will start to formulate their thesis research topic soon after the end of the first semester of their registration, in consultation with their supervisors. This task includes a review of the literature related to the thesis topic, determining the research objectives, approaches, and anticipated research results. Within the third semester of registration, the graduate students are expected to present their work including any preliminary results, to an audience composed of Civil Engineering faculty members, graduate and undergraduate students.

Full-time registered students admitted to the program will normally complete all requirements for the program within six consecutive terms (24 months) from

commencement of study. Part-time students are expected to complete all requirements within a minimum of fifteen terms (5 years) of continuous part-time registration.

5. Program Content

5.1 Curriculum

In order to complete the requirements for the MSc in Civil Engineering, all students will be required to complete course work, a seminar, and a thesis. Students will specialize in an area of faculty expertise through their choice of course work and choice of seminar and thesis topics. The areas of specialization in the proposed MSc program include not only the general Civil Engineering fields (e.g., steel structures, earthquake resistance, traffic flow, water resource, waste water treatment, foundation engineering), but also new and emerging areas such as fire safety, mining and structural optimization. The expertise of the faculty members covers environmental, geotechnical, structural, hydrological, transportation, and water resource engineering. Evidence for this is provided in the curriculum vitae of the individual faculty members (Volume II).

5.2 Program Innovations

The Civil Engineering MSc program at Lakehead University will cover and serve a large geographical area of Northwestern Ontario. An innovative feature of the proposed MSc program is that faculty members will consult with local industry sectors and government agencies, and will pursue industry-based research projects that will provide graduate students with a cutting-edge and application-oriented program that will lead to opportunities for excellent jobs locally and nationally.

An Industry Advisory Committee is planned to be established by September 2013. The committee will be composed of principals, chief engineers, and directors from local engineering firms, contractors or fabricators, and government agencies. The committee will meet regularly to discuss and advise on issues related to the graduate program.

5.3 Research Requirements

Each student will be assigned a supervisor at the point of admission by the Graduate Studies Committee. Active supervision of all graduate students will be provided by their supervisor and co-supervisor when one is involved. All students are required to report their progress to their supervisors on a mutually agreed upon basis.

The MSc program culminates in the preparation of a thesis that reports the results of an independent research investigation that may be fundamental in nature, or applied, and that incorporates a creative design. Students will give evidence of competency in research, and present a sound understanding of the area of specialization.

Graduate students will be required to give at least one presentation at departmental seminars to gather comments on their research work from professors and other students prior to their thesis oral defence. The seminar should provide a comprehensive survey of existing literature in the related research field and

demonstration of systematic understanding of knowledge with the required depth and breadth. The seminar is also assessed based on the effectiveness of the oral presentation and the ability to respond to questions posed during the seminar. The seminar presentation is evaluated by the Supervision Committee including the student's supervisor(s) and at least one more faculty member who is familiar with the topic of research. Each student is also required to attend other departmental seminars, to develop the skills to critically evaluate existing knowledge and to communicate ideas clearly and effectively.

The MSc thesis defence is the final evaluation of an MSc candidate's work. The candidate's entire committee must attend either in person, or via teleconference, or through the proxy of another faculty member to whom they have given clear questions and instructions to evaluate the candidate.

The student must produce an MSc thesis, which must be submitted to each member of the committee at least one month prior to the defence. Arrangements for oral examination will be made by the thesis supervisor, in consultation with the Graduate Coordinator. The supervisor will serve as Chair of the exam.

All MSc oral examinations are open to the public, unless otherwise requested by both the student and the supervisor. At the beginning of the defence, the student will make the presentation of the thesis followed by a question period related to the thesis from the Committee. The presentation is limited to 45 minutes. After the presentation, the student will take questions from the audience. The candidate and audience will then be asked to leave the room, as the Committee deliberates. If a candidate has more than one supervisor, only one supervisor may vote. After the exam, the votes are recorded by the exam chair and the results are returned immediately to the Graduate Coordinator. The deliberations must take into account the thesis, the presentation and the student's answers to the oral questions in the question period. Once the Committee makes its decision, the candidate will be called back into the room and informed of the decision. One of four decisions may be reached:

(a) The candidate passes the defence. This decision may be qualified by the requirement of minor revisions, such as the correction of grammatical errors identified by the Committee members in the thesis or the clarification of specific statements in the thesis. It may or may not be requested that the supervisor reviews these corrections.
(b) The candidate conditionally passes the defence. This decision must be justified by a non-trivial amount of remedial work, such as a significant discussion to be added to the background review, a supplementary set of empirical experiments needed to study the problem, or an important analysis of the results to be conducted. This work should normally take about a month to complete. These corrections must be reviewed by the supervisor, and optionally by any other committee member who deems it necessary.
(c) The candidate is required to repeat the defence. This decision means that major work remains to be done in the research, and this additional work will require several months to complete. This work should normally be of both a theoretical and applied nature, and must be clearly identified by the

Committee members. Subsequently, the candidate will have to update the thesis and repeat the defence.

(d) The candidate fails the defence. This decision means that the research is fundamentally flawed and the project is unsalvageable. The candidate who fails the defence is automatically expelled from the program.

In addition, MSc students are encouraged to present their research results at academic conferences. Lakehead University provides a Graduate Student Professional Development Bursary of $500 (not available to international students) to support graduate students to attend conferences at which the student makes the presentation.

5.4 Course Requirements

(1) Degree Requirements

The requirements for the MSc program are 5 full-credit equivalent (FCE) courses made up of: 4 half-courses (2 FCEs), a seminar course (0.5 FCE) and a thesis (2.5 FCEs). All students must take at least three of the following half-courses:

Engineering 5190: Modeling Techniques in Water Resources
Engineering 5191: Stochastic and Statistical Methods in Water Resources
Engineering 5151: Geoenviromental Engineering
Engineering 5451: Physicochemical Treatment Processes
Engineering 5390: Computer Applications in Traffic Engineering
Engineering 5391: Highway Safety
Engineering 5590: Advanced Foundation Engineering
Engineering 5591: Geomaterials Properties and Behaviour
Engineering 5592: Finite Element Analysis for Civil Engineering Applications
Engineering 5593: Structural Design for Fire Resistance
Engineering 5594: Advanced Structural Steel Design
Engineering 5595: Structural Dynamics and Earthquake Engineering
Engineering 5691: Advanced Topics in Civil Engineering

At least four of these courses will be offered every year. One of the four half-courses may be taken from another existing graduate program at Lakehead University. A student can take only one graduate reading course under Engineering 5691: Advanced Topics in Civil Engineering to be credited as a half-course. One of the four half-courses may be a senior undergraduate half-course that has not previously been taken. The student's choice of courses must be approved by the graduate supervisor and the Graduate Program Coordinator.

The student learner outcomes of the listed graduate courses are summarized in Appendix E, which are aligned with the Program Learner Outcomes and the Graduate Degree Level Expectations.

(2) Minimum Satisfactory Academic Standing

All graduate students must maintain a minimum mark of 70% (B) in each half-course. A grade of less than 70% will constitute a failure. A failed half-course may either

be repeated or replaced only once by another course specified by the supervisor. Any student with more than one half-course failure must withdraw from the program.

A course mark below 50% is unacceptable. A student with such a mark will not be permitted to continue in the program. Courses with a mark below 50% may not be repeated.

6. Mode of Delivery

6.1 A Description of Modes of Delivery

This program will combine several modes of delivery:

(a) Course work: students are expected to take four half-credit courses. Basic course learning activities include attending lectures and completing assignments; some courses may include a project, laboratory hands on activities and/or demonstrations and site visits to enhance learning.

(b) Research work: this program is research-oriented, and students are expected to accomplish independent research work. While the details will vary and be at the discretion of the supervisor, this research will normally have both a theoretical and an experimental component.

(c) Thesis: students are expected to produce a thesis describing and implementing their research work.

(d) Oral presentations: students are expected to pass an oral research seminar and an oral thesis defence.

6.2 A Discussion on the Appropriateness of the Proposed Modes of Delivery to Meet the Intended Program Learner Outcomes and Degree Level Expectations

The modes of delivery relate directly to the learners outcomes defined previously.

(a) Course work: This will provide students with foundations in the concepts, tools and methods in their area of study. It will be useful for them to get started on the background review, and to get ideas for methods throughout their research work.

(b) Research work: Producing independent research work is central to the MSc program. Students must solve a variety of types of problems similar to those they will encounter in their future employment/research work, obtain valid results and analyze them objectively.

(c) Thesis: Scientific research is not simply conducting experiments, but also is concerned with properly documenting the methodology and conditions used and the results obtained. The production of a thesis is the culmination of the research work in the previous point.

(d) Oral presentations: Students must develop the ability to communicate their research work, results and conclusions in clear, complete and scientifically-accurate presentations to an audience of peers not necessarily versed in that specific area of knowledge. The two oral presentations in the program, the Seminar and Defence, accomplish this goal.

7. Assessment of Teaching and Learning

7.1 Student Assessment

Each component of the MSc curriculum will be assessed as described below in order to ensure that graduates of the program achieve the stated Program Learner Outcomes and meet the Degree Level Expectations.

(a) Students will achieve a grade of at least 70% in each of the four half-credit courses they take. The course work is assessed based on the related Student Learner Outcomes, (Appendix E) through assignments, project, project presentation, and examinations. (Links to Program Learner Outcomes: a, d, e, f, g)

(b) The seminar presentation is evaluated by the Supervision Committee including the student's supervisor(s) and at least one other faculty member who is familiar with the topic of research. The assessment is through the survey of existing literature in the related research field, demonstration of depth and breadth of knowledge, strategy and methodology to tackle research challenges, as well as the effectiveness of the presentation and question answering. (Links to Program Learner Outcomes: a, b, e, g, h)

(c) The progress of the student through the program is monitored by the Supervision Committee including the student's supervisor(s) and at least one other faculty member who is familiar with the topic of research. (Links to Program Learner Outcomes: a, b, c, d, e, f, g, h)

(d) The final thesis defence is evaluated by the Graduate Examination Committee. The composition of the committee will consist of the student's supervisor(s) and at least two thesis examiners. One of the examiners will be external to the graduate program of the candidate, to ensure objectivity. Selection of the external examiner is made by the Thesis Committee, in consultation with the Graduate Coordinator. (Links to Program Learner Outcomes: a, b, c, d, e, f, g, h)

8. Resources for Graduate Programs

8.1 Faculty and Staff

Evidence of how supervisory loads will be distributed, and the qualifications and appointment status of faculty who will provide instruction and supervision

TABLE 2. Faculty Members

Name and Rank	M/F	Year Appointed	Home Unit at University	Supervisory Privileges	Field
					Civil Engineering
A. Gillies, Assoc. Prof.	M	1983	Civil Eng.	Full	X
B. Kjartanson, Assoc. Prof.	M	2003	Civil Eng.	Full	X
E. Mohamedelhassan, Assoc. Prof.	M	2005	Civil Eng.	Full	X
J. He, Assist. Prof.	F	2011	Civil Eng.	Full	X
J. Pernia, Assoc. Prof.	M	2004	Civil Eng.	Full	X
O. Salem, Assist. Prof.	M	2012	Civil Eng.	Full	X
U. Panu, Prof.	M	1986	Civil Eng.	Full	X
W. Gao, Prof.	F	2001	Civil Eng.	Full	X
Y. Gong, Assoc. Prof.	M	2003	Civil Eng.	Full	X

Of the listed faculty members, Dr. O. Salem and Dr. J. He are new faculty members starting in 2012 and 2011, respectively. Five of the nine core faculty members have been actively involved in teaching and supervision in the Master's Programs in Environmental Engineering. All faculty members will teach courses and supervise students in the proposed MSc in Civil Engineering.

All faculty members are active researchers who have a continuing record of producing peer-reviewed publications. More details are summarized in Volume II.

8.2 Research Funding

Operational research funding awarded to faculty members over the past seven years amounted to $1,091,603, as detailed in Table 3a.

TABLE 3a. Operational Research Funding by Source and Year

Year[1]	Source				
	Federal Granting Councils[2]	Other Government Grants[3]	Foundations	Industry & Contracts	Others
2005-06	$69,125			$22,167	$21,885
2006-07	$96,813	$40,936		$14,606	$600
2007-08	$106,500	$38,875		$50,333	$1,905
2008-09	$107,500	$74,802		$11,000	$7,581
2009-10	$91,500	$24320			$2,200
2010-11	$90,000	$37,852	$7,000	$3,500	$8,400
2011-12	$38,000	$60,370		$53,833	$10,000
Totals	*$599,438*	*$277,155*	*$7,000*	*$155,439*	*$52,571*

[1] Academic year.
[2] Includes: Examples: NSERC Discovery and Strategic.
[3] Includes: Examples: Ontario Centres of Excellence (OCE); FedNor; Industry Canada.

Funding awarded for research instrumentation to faculty over the past seven years amounted to $44,281, as detailed in Table 3b.

TABLE 3b. Research Instrumentation Funding by Source and Year

Year[1]	Source				
	Federal Granting Councils[2]	Other Government Grants	Foun-dations	Industry & Contracts	Others
2005-06	$30,756				
2006-07		$7,250		$7,250	$5,000
2007-08					
2008-09	$10,281				
2009-10					
2010-11					
2011-12		$7,250		$7,250	
Totals:	$10,281	$14,500		$14,500	$5,000

[1] Academic years.
[2] Includes: Examples: CFI; NSERC-RTI.

8.3 Teaching Assignments

TABLE 4a. Teaching Assignments for 2009/10

Faculty Member	Rank	Teaching Assignments for 2009/10[1]		
		Undergraduate	Graduate	Comments[2]
A. Gillies	Assoc. Prof.	Engi-3056 Engi-4135 Engi-1630 Engi-0652 Engi-4969 (12)		
B. Kjartanson	Assoc. Prof.	Engi-3150 Engi-3738 Engi-2433 Engi-0437 Engi-4969 (7)	Engi-5151 Engi-5901 Engi-5811	
E. Mohamedelhassan	Assoc. Prof.	Engi-2139 Engi-2639 Engi-3433 Engi-0534 Engi-4969 (14)		
J. He				New faculty member starting from Fall 2011
J. Pernia	Assist. Prof.	Engi-0553 Engi-2138 Engi-3336 WA Engi-3336 WB Engi-4969 (6)		
O. Salem				New faculty member starting from Fall 2012
U. Panu	Prof.	Engi-4042 Engi-0572 Engi-4969 (6)		Secondment to Research Office as Associate Vice President Research
W. Gao	Assoc. Prof.	Engi-2431 Engi-4056 Engi-0336 Engi-4969 (12)	Engi-5451	
Y. Gong	Assoc. Prof.	Engi-3452 Engi-0233 Engi-4969 (13)		Sabbatical leave (fall term)

[1] Engi-4969 is degree project. The number of students is given parenthetically.
[2] Reduced teaching load.

TABLE 4b. Teaching Assignments for 2010/11

Faculty Member	Rank	Teaching Assignments for 2010/11[1]		
		Undergraduate	Graduate	Comments[2]
A. Gillies	Assoc. Prof.	Engi-1630 Engi-0652 Engi-4969 (13)		
B. Kjartanson	Assoc. Prof.	Engi-3738 Engi-0437 Engi-4969 (12)	Engi-5151 Engi-5901 Engi-5811	Sabbatical leave (fall term)
E. Mohamedelhassan	Assoc. Prof.	Engi-3150 Engi-2639 Engi-3433 Engi-0534 Engi-4969 (14)		
J. He				New faculty member starting from 2011
J. Pernia	Assoc. Prof.	Engi-0553 Engi-2138 Engi-3336 WA Engi-3336 WB Engi-4969 (18)		
O. Salem				New faculty member starting from 2012
U. Panu	Prof.	Engi-4042 Engi-0572 Engi-4969 (6)		Secondment to Research Office as Associate Vice President Research
W. Gao	Assoc. Prof.	Engi-2431 Engi-4056 Engi-0336 Engi-4969 (11)	Engi-5451	
Y. Gong	Assoc. Prof.	Engi-3056 Engi-3435 Engi-4230 Engi-0233 Engi-4969 (14)		

[1] Engi-4969 is degree project. The number of students is given parenthetically.
[2] Reduced teaching load.

TABLE 4c. Teaching Assignments for 2011/12

Faculty Member	Rank	Teaching Assignments for 2011/12[1]		
		Undergraduate	Graduate	Comments[2]
A. Gillies	Assoc. Prof.	Engi-1630 Engi-2432 Engi-3335 Engi-4135 Engi-0652 Engi-4969 (14)		
B. Kjartanson	Assoc. Prof.	Engi-3150 Engi-2139 Engi-3433 Engi-0437 Engi-4969 (11)	Engi-5151 Engi-5901 Engi-5811	
E. Mohamedelhassan	Assoc. Prof.			Sabbatical leave (whole year)
J. He	Assist. Prof.	Engi-2431 Engi-3336 Engi-3738 Engi-4969 (8)		New faculty member starting from 2011
J. Pernia	Assoc. Prof.	Engi-0553 Engi-2138 Engi-2639 Engi-3336 Engi-4969 (12)		
O. Salem	Assist. Prof.			New faculty member starting from 2012
U. Panu	Prof.	Engi- 4042 Engi- 0572 Engi- 4969 (11)		Secondment to Research Office as Associate Vice President Research
W. Gao	Prof.	Engi-4056 Engi-0336 Engi-4969 (5)	Engi-5451	Dept. Chair, 1st year teaching reduction
Y. Gong	Assoc. Prof.	Engi-3056 Engi-3452 Engi-4230 Engi-0233 Engi-4969 (17)		

[1] Engi-4969 is degree project. The number of students is given parenthetically.
[2] Reduced teaching load.

9. Financial Support for Graduate Students

9.1 Scholarships

Graduate students in the proposed program may compete for scholarships, such as Ontario Graduate Scholarships (OGS), and NSERC Graduate Scholarships.

9.2 Graduate Assistantships

Lakehead University provides Graduate Assistantships (GAs) for domestic full-time graduate students (including some international students) at a rate of $9,303 per year at the Master's level (level of support for 2012-13). The GAs are available during the Fall and Winter terms. The normal duties of a regular GA recipient are marking and consulting with students, working a maximum of 270 hours and not averaging more than ten hours per week.

9.3 Other Supports

Supplemental funding may be provided to qualified graduate students by their graduate supervisors from research grants. Lakehead University also offers a variety of additional Scholarships, Awards, and Bursaries to qualified graduate students. The University has experienced growth in the number of OGS awards and students are also encouraged to seek support from agencies such as NSERC. Finally, the Faculty Academic Plan proposes that future internal funds (e.g., indirect, recovery, donations, etc.) will be used when available to support graduate students. Developing the graduate program and securing the necessary resources (staff, graduate students, space) to ensure the success of the program is a Faculty priority.

10. Physical & Financial Resources

10.1 Library Resources:

The library resources are sufficient to support the research needs of the proposed program. A summary statement by the Chief Librarian of the University is provided in Appendix A.

10.2 Classroom, Laboratory and Research Equipment and Facilities:

The existing laboratory and instrumentation resources are sufficient to support the research needs of the proposed program. A summary of the main research equipment and common facilities available to the proposed program is given in Appendix B.

10.3 Computer Facilities and Information Technology Support:

Networked computer facilities will be available to the students of the proposed program. There are several general computer labs and classrooms, which are maintained by the Technology Services Centre (TSC) at Lakehead University. A summary statement by the Supervisor of Client Services of the Technology Services Centre of the University is provided in Appendix C.

All faculty members in the proposed program have Internet access in their offices. If necessary, students in the proposed program will be provided with computers by their supervisors. The existing computer resources and IT are satisfactory to support the research needs of the proposed program.

10.4 Working Space for Faculty and Graduate Students:

All faculty members have private offices with telephones and internet connections. Adequate space will be made available for all graduate students. For those students who have a Graduate Assistantship, the space requirement is mandated by the Collective Agreement for CUPE 3905, the union to which all Graduate Assistants belong.

There are two desk spaces available for graduate students in Civil Engineering research labs (Table 5) (Note that the Department of Mechanical Engineering has 21 desks in their labs, which is enough to accommodate their own students). Currently, the Faculty of Engineering has 30 desks for graduate students (18 seats in RL1004 through RL1009 and 12 seats in CB3034). Among them, five are occupied by the students (who are supervised by Civil faculty members) registered in the existing graduate program in Environmental Engineering.

Table 5 - Space Allocations of Program Faculty and Students

Faculty Member	Home Unit	Building – Room		
		Office	Lab	Available Desk Space for Students
A. Gillies	Civil Eng	12 m^2		
B. Kjartanson	Civil Eng	12 m^2		
E. Mohamedelhassan	Civil Eng	12 m^2	Geotechnical Lab II CB0038[1] (65 m^2)	1
J. He	Civil Eng	12 m^2		
J. Pernia	Civil Eng	12 m^2	Pavement Lab CB0022[1] (47 m^2)	
O. Salem	Civil Eng	12 m^2		
U. Panu	Civil Eng	12 m^2	Hydrology & Water Resources Lab CB0045 (16 m^2)	1
W. Gao	Civil Eng	12 m^2	Environmental Engineering Lab CB0031[1] (56 m^2)	
Y. Gong	Civil Eng	12 m^2		
Total available desk spaces for students:				***2***

[1]Included in Appendix B

There are totally 42 students in all existing engineering graduate programs in Fall 2012 (data from Engineering Dean's office). Hence, about eleven student desks are still available for future growth. For the first two to three years, the current working space may be able to accommodate civil graduate students. In the long run, more working space may be required for graduate students as every engineering department is developing its own graduate program. Extra desk space may be created by turning some current classrooms into working space, e.g., rooms CB4070 and CB4106 were turned into offices in recent years. Common graduate student space is available through the Graduate Faculty on an as-needed basis.

A campus map is attached to Appendix F to specify the buildings where office and lab spaces are located.

11. Quality and Other Indicators of the Related Faculty Members

The faculty members in the proposed MSc in Civil Engineering are active researchers with a continued record of peer-reviewed publications, as summarized in Table 6.1 (lifetime publications). Details can be found in Volume II.

Table 6.1 - Summary of research contributions of the faculty members

Faculty Member	Refereed Journal Papers	Refereed Conference Papers	Book Chapters
A. Gillies	2+	2+	0
B. Kjartanson	22	21	2
E. Mohamedelhassan	16	16	1
J. He	9	6	0
J. Pernia	7	11	0
O. Salem	1	6	0
U. Panu	45+	60+	10
W. Gao	18	5	0
Y. Gong	27	11	1

Most of the faculty members in the proposed MSc in Civil Engineering also have experience in supervising highly-qualified personal (HQP) including MSc and PhD students and postdoctoral fellows, as summarized in Table 6.2 (including the HQP from previous employments). The list includes those graduate students both completed and in-progress from the existing MSc Eng program in Environmental Engineering or from the other universities where faculty members supervised as adjunct professors.

Table 6.2 - Summary of thesis supervision of the faculty members

Faculty Member	Master Students	PhD Students	Postdoctoral Fellows	Adjunct Professorship Appointment
A. Gillies	1	0	0	
B. Kjartanson	22	4	1	
E. Mohamedelhassan	5	1	0	University of Western Ontario
J. He	0	0	0	
J. Pernia	2	0	0	
O. Salem	0	0	0	
U. Panu	10	3	5	University of Waterloo, University of Manitoba
W. Gao	7	0	0	
Y. Gong	0	1	0	University of Waterloo

12. Budget

1) There are nine faculty members as well as two technologists in the Department of Civil Engineering. This is sufficient to begin the MSc graduate program. An additional faculty member may be hired once the MSc program grows sufficiently.
2) We expect to reach a steady state in the program in five years. Projected steady-state enrolment is 18 MSc students including 14 domestic and four international students. Each faculty member is assumed to supervise two students each year. Table 7 summarizes projected graduate enrolments in the proposed program and the related budget.
3) Currently Lakehead University provides Graduate Assistantships (GAs) for full-time domestic graduate students at a rate of $9,303 per year (level of support for 2012-13). This support may also be offered to a limited number of international students. In calculating expenses, it is assumed that all domestic students are to be assigned GAs, which is the current practice, but none of the international students will receive GAs.
4) Graduate students may also be offered Faculty Research Assistantships by their graduate supervisors from research grants, and various donor-funded awards. These are not included in this budget.
5) This budget does not account for increases in salaries, costs, tuition, funding, etc.
6) The budget assumes that new sessional instructors will be hired to teach undergraduate courses. This will free up faculty members to teach the graduate courses required for this MSc program.

7) Though it is expected that the proposed graduate program will require some technical support from lab staff, the additional demands seem to be manageable based on the planned research activities. Thus, hiring of new technologist is not proposed in the budget.
8) Student retention rate is assumed to be 90% for calculating both Revenues and Expenditures.
9) It is estimated that the demand of enrolment is 50 graduate students based on the program demand analysis in Section 1.5. The projected enrolment in Table 7 is modest and achievable.

TABLE 7 - Projected enrolment for graduate students in the proposed program and the related budget

	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018
New full-time domestic students	4	6	6	7	7
Continuing full-time domestic students	0	4	6	6	7
New full-time international students	1	2	2	2	2
Continuing full-time international students	0	1	2	2	2
Part-time students	0	0	0	0	0
TOTAL students	**5**	**13**	**16**	**17**	**18**
Tuition for domestic students ($2,189/term)	23,641	59,103	70,924	76,834	82,744
Tuition for international students ($4,950/term)	13,365	40,095	53,460	53,460	53,460
Funding (BIU) for domestic students ($13,600/year)	48,960	122,400	146,880	159,120	171,360
TOTAL Revenues	**$85,966**	**$221,598**	**$271,264**	**$289,414**	**$307,564**
Graduate Assistantships ($9,303/year)	33,491	83,727	100,472	108,845	117,218
New faculty member	0	0	100,000	100,000	100,000
New technologist	0	0	0	0	0
New sessional instructors for teaching undergraduate courses ($8,000/course)	24,000	40,000	0	0	0
Consumables	10,000	10,000	10,000	10,000	10,000
Marketing	10,000	10,000	10,000	10,000	10,000
TOTAL Expenditures	**$77,491**	**$143,727**	**$220,472**	**$228,845**	**$237,218**
NET INCOME	**$8,475**	**$77,871**	**$50,792**	**$60,569**	**$70,346**

Appendix A: Library Resources

PROPOSED MSc PROGRAM IN CIVIL ENGINEERING LIBRARY RESOURCES

Collections

The Chancellor Paterson Library maintains a solid collection of monographs and serial publications on the subject of Civil Engineering and a well-established collection of resources in related engineering disciplines that will support the proposed Master of Science in Civil Engineering Program. The Library currently supports graduate level engineering programs in Environmental Engineering, Electrical and Computer Engineering and the interdisciplinary Control Engineering program.

The Library's journal collection, in particular the electronic journals, is strong. Subscriptions paid from the library budget for the Faculty of Engineering include 33 online journals from the American Society of Civil Engineers (ASCE) and 19 titles from the Institution of Civil Engineers (ICE). In addition, the Library provides access to electronic journals through participation in the Canadian Research Knowledge Network (CRKN) and consortial subscriptions through the Ontario Council of University Libraries (OCUL). Suites of electronic journals such as *Elsevier's Science Direct, SpringerLink*, *Taylor and Francis*, *IEEE/IET Electronic Library (IEL), Sage Journals Online* and *Wiley-Blackwell* are available. The Library provides access to approximately 840 electronic journals of interest to civil engineering.

The library has approximately 24,400 print and electronic monographs in the library of congress classification ranges for engineering disciplines. Of these, there are approximately 3,300 print monograph titles specific to Civil Engineering (Class TA), 1150 titles on the subject of Technology (ClassT), 2000 titles in environmental technology which includes municipal engineering (Class TD), almost 2000 titles on Highway engineering (Class TE), and over 500 titles on bridge and building construction (classes TG and TH). Electronic-book packages purchased consortially, such as the Springer collection, add substantially to the depth and currency of the monograph collection.

Selection

The Faculty of Engineering is responsible for selecting appropriate library resources. A library representative from the Faculty of Engineering liaises with a designated Collections Development Librarian with respect to the Faculty's library budget, the acquisition process, and consortia and serials management. It is the responsibility of the Collections Development Librarian to ensure relevant information regarding new publications is forwarded to the Faculty's representative for consideration.

Budget

The portion of the Library's books and periodicals budget expended by the Faculty of Engineering for 2011/12 was $51,268. This figure does not include the cost of

databases, indexes, abstracts and reference materials paid for from other library funds. It also does not include the cost for purchasing suites of electronic books such as the Springer collections or the costs for subscribing to packages of electronic journals through CRKN and OCUL.

Access to Campus Resources

A special room in the Chancellor Paterson Library has been designated for the exclusive use of graduate students. Access to the internet is available wirelessly or via workstations located throughout the Chancellor Paterson Library. Laptop computers are available from the Circulation Desk for students to borrow. In addition, there are two computer labs, one of which is located on the main floor and is part of the Library Learning Commons. The Library Learning Commons also includes group study rooms, tutoring rooms and a presentation practice room.

The Library's catalogue, *Voyager*, provides a single access point for the Library's holdings and a variety of resources including indexes, abstracts, e-books and full text electronic journals and government publications.

Availability of Resources to Identify Relevant Information

The Library's collection includes a number of electronic databases which would support the proposed program.

Compendex provides access to over five million summaries of journal articles, technical reports, and conference papers and proceedings in all areas of engineering.

Inspec is a bibliographic database to access 3500 scientific journals and 1500 conference proceedings in the fields of electrical and electronic engineering, physics, information technology, and computer and control systems.

Web of Science provides access to the Institute of Scientific Information's *Science Citation Index Expanded*.

ASTM Standards from IHS Engineering Resource Center, provides access to the full-text of current active standards.

The *Synthesis Digital Library of Engineering and Computer Science* is an information service for the research, development and educational communities in engineering and computer science.

The *IEEE/IET Electronic Library (IEL*) provides access to electrical engineering and computer science literature, featuring high-quality content from the Institute of Electrical and Electronics Engineers (IEEE) and the Institution of Engineering and Technology (IET).

Access Science is the online version of McGraw-Hill Encyclopedia of *Science* and Technology. This reference database provides access to dictionary definitions, encyclopedia entries, and research articles.

IngentaConnect is an index to over 22,000,000 current articles taken from over 30,000 multidisciplinary journals.

The Scholars Portal Book platform provides a single interface for accessing e-books from a number of publishers as well over 280,000 open access titles.

Scholars Portal Journals is a digital repository of scholarly articles from every academic discipline.

Proquest Dissertations and Theses (PQDT) is a comprehensive collection of over 2.3 million dissertations and theses from around the world. Citations are available for dissertations dating from 1861 and more than 60,000 new citations are added to the database every year. From 1997 onward content is available in full-text.

The Library provides access to *Theses Canada Portal*, an initiative of Library and Archives Canada, which provides full-text of Canadian theses and dissertations from 1998 to August, 2002 and bibliographic records for Canadian theses since 1965.

Provision of Documents and Information Not Held Locally

The library provides document delivery/interlibrary loan services to enable access to articles and research materials that are not held in the Lakehead University collection.

Lakehead is also a participant in the Inter University Borrowing Project (Canada) to facilitate the borrowing of books from other libraries.

User Assistance

Professional Reference Librarians are available to assist students in person, by telephone, or by email in making full use of the Library's resources. These include but are not limited to the online catalogue, electronic databases, electronic journals, internet resources, electronic books, statistical data, and access to other library catalogues. The Library has an integrated Research Help/IT Desk at which Professional Reference Librarians provide assistance approximately 66.5 hours per week during the fall and winter terms and Technical Services Centre staff provides IT assistance approximately 56 hours per week. In addition, Lakehead University Library is a participant in the Ask: Chat with a Librarian collaborative online reference service which is provided by OCUL member university libraries. Approximately 66 hours of live chat reference service is provided by participating OCUL institutions each week during the fall and winter terms.

The Library's web page includes subject guides which present selected print and electronic information sources for each area of study at Lakehead University. These guides were prepared and are updated regularly by the Library's professional librarians.

ER Update, the Library's electronic resources blog, provides information on new electronic Library resources as well as interface changes, additional features, and maintenance windows.

The Library offers a series of workshops intended to teach research skills and develop a knowledge base for optimizing use of the Library's resources. Advanced level and discipline-specific sessions can be arranged upon request either for individuals or classes. Workshops are also available on the use of *Refworks,* a web-based bibliography and database manager that allows one to create one's own personal database by importing references from text files or online databases.

_____ _____

Anne Deighton: University Librarian Date: June 2012

Appendix B: Laboratory Facilities

Modern, well-equipped laboratories are available for both research and teaching. A list of the major research equipment within the academic unit is given below.

1. Structures Lab (CB-1045, 312 m^2)

- One 2225 kN SATEC universal testing machine with digital readout, for specimens up to 2.75 m length, certified calibration.
- One 1110 kN Forney compression testing machine.
- Two large structural load frames consisting of 4WWF 350x176 (WWF 14x118) steel columns, 5.4 m high, with moveable cross members and a large double load bed system. This double load beam system also serves as a bed system for the SATEC testing machine.
- Vishay Model 5100 Scanner and IBM PC for data acquisition of SATEC. Loads and displacement can be recorded from the universal testing machine as well as additional channels of data from the test specimen (up to 18 additional channels).
- Cellular structural test floor 312 m^2x0.6 m thick with 350 tie down points at 0.5 metre centres and 227 kN (25 ton) capacity each
- One 10 ton overhead travelling bridge crane (with 11 m working height below crane)
- Several enerpac hydraulic jacking equipment with from 89 kN to 1780 kN rams
- One electric hydraulic power pump and several smaller hand pumps
- One Miller welding machine “millermatic 211”
- One king 5”x6” metal cutting bandsaw
- One 15’x15’ aggregate conveyer
- Ten linear displacement sensors
- One storage tank for submerged curing of concrete cylinders
- One cold room, 1.5 mx1.5 mx2.0 m with temperature control from –30 deg.C to +30 deg.C.
- Three Concrete mixers [1.0 m^3, 0.7 m^3 and 0.25 m^3]
- One end grinding machine for concrete specimens
- Mixing pans
- Slump cones
- Cylinder and beam moulds
- Yield buckets
- One flow table
- One concrete vibrator
- One 8 kg Electronic scale
- One horizontal and vertical capping apparatus for normal strength concrete cylinders
- One special capping apparatus for high performance concrete cylinders
- One concrete test hammer
- One concrete saw

- One large concrete bucket for use with crane in pouring specimens with ready mix concrete
- Compressometer
- One apparatus for modulus of rupture tests
- Vicat apparatus
- Large aggregate storage bins
- Specimen moulds and air extraction system
- Double celled geotechnical test pit which can be serviced by 10 ton bridge crane; 2.2 m x 3.6 m x 2.4 m deep, in which depth of water table can be varied, surrounded by a series of 227 kN (25 ton) tie-down points.

2. Geotechnical Lab (CB-1035, CB-0022 & CB-0038, 227 m^2)

- Digital tritest load frame
- Triflex 2 master control panel
- Triflex 2 auxiliary control panel
- Three Triflex permeability test cells
- Two pressure interface chambers
- Triflex de-airing tank
- Two Rowe consolidation cells
- Two “S”-type load cells
- Three linear displacement sensors
- Four D.C power supplpy units
- Two Geonor triaxial cells with rotating bushing
- One Wykeham Farrance triaxial cell with rotating bushing
- Two Reversing direct shear machines
- Four Consolidometers (with air pressure and dead weight)
- One thin wall hydraulic soil sample extruder
- Two permeability test arrangements for falling and constant head tests
- Equipment for soil classification for Atterberg limit tests, sieves and sieve shaker, hydrometer tests, specific gravity tests, moisture-density tests
- Two - unconfined compression test frame (89 kN capacity)
- Various proving rings (45 kN to 220 kN)
- Proctor compaction equipment
- CBR testing equipment
- Los Angeles abrasion machine
- Three ovens
- One waterbaths
- Three sample splitters
- Two laboratory mixers
- One automatic Marshall compaction apparatus
- One marshall stability test apparatus
- Two - kinematic viscometer and 1 - Saybolt viscometer
- Other equipment such as timers, electronic balances.
- Coldmatic walk-in freezer 2.4m^2

- Coldmatic walk-in moist room 4.7m^2
- Vishay Model 5100 datalogger/scannerand IBM PC on mobile cart
- One Troxler Model B gyratory compactor for superpave asphalt specimens
- Slope indicator with read-out unit
- Nuclear density meter
- Soil/water testing field kit
- Rubber balloon and sand cones for in-place density
- Various load cells for total pressure and pore water pressure
- Melting pot for waxing of soil samples
- Various field hand-augers
- Three – jet fill tensiometers
- Other equipment such as pocket penetrometers, field vane testing devices, water level recorders.

3. Materials Science Lab (CB-1013, 133.6 m^2)

- Grinding and lapping benches (Buehler)
- Mounting press (Buehler)
- Polishing benches (Buehler)
- Ultrasonic cleaning apparatus
- Leitz metallurgical microscopes with camera facilities
- 1200°C muffle furnace (Bluem)
- 1200°C tube furnace (Lindberg)
- 1000°C ovens (1 Lindberg, 1 Dyna-Trol)
- Brinnel hardness tester (Tinius Olsen)
- Rockwell hardness testers (1 Wilson, 1 Louis Small)
- Series 2000 Rockwell hardness tester (Instron)
- Vickers micro-hardness tester (Leitz)
- Creep testing apparatus (4, made at Lakehead University)
- Fume cabinet (Labconco)
- Oil and water quenching baths
- Conductance meter (YSI)
- Six light tables
- Jelrus furnace
- 70-1740 micromet etcher (Buehler)
- Large mountable magnifying glass
- Plastic specimen tension tester (Comten)
- Auto-balance universal bridge (Wayne Kerr)
- Potentialstat/Galvanostat (Princeton Applied Research)
- Four channel alarm timer (Cole-Palmer)
- Flat bar rollers (2, cold work apparatus)
- Variable Auto-transformer (2, Staco)

4. Mechanics of Materials Lab (CB-1038 & 1038A, 110.5 m^2)

The lab is used for basic materials testing, such as tension, compression, torsion and bending; it also contains model units for the studies of the behaviour of structural elements, such as beams and struts.

- Ten-channel digital readout strain indicator system (Vishay Ellis)
- Photo-elasticity equipment including a transmission polariscope, load cell readout, and an overhead projector teaching polariscope (Photolastic)
- Tinius Olsen impact testing machine
- Tinius Olsen torsion testing machine [1130 N-m capacity]
- Tinius Olsen Universal Testing machines [267 kN capacity]
- • Small universal testing machine [45 kN capacity] (Louis Small)
- MTS Load Frame 90kN capacity
- MTS Load Frame 445kN capacity
- MTS SE Digital Controller
- Compaq computer with FlexTest SE software
- Vishay Model 5130 Scanner and IBM PC on mobile cart
- Small shake table
- Data acquisition for Tinius Olsen, digital calipers, LVDT
- Sixteen channel Scientific Instruments data acquisition "System 200" for thermistors, pressure cells and LVDT's
- Eight channel field data logger, "Lakewood Systems" for thermistors and pressure cells
- Two OMNIDATA - "Easy Logger" field units with one "Easy Logger" terminal
- National Instruments Labview software, DAQ Pad (computer data acquisition interface), signal conditioning and terminal blocks for 8 channels of data acquisition,
- Tinius Olsen Retrofit complete with Vertex data acquisition P.C. software and colour printer
- Four Vishay 5100 series scanners complete with StrainSmart software NOTE: All laboratory data acquisition systems are connected to IBM compatible PC's.
- One 16”x40” metal lathe with DRO and assorted attachments
- One 9”x49” vertical knee mill with DRO and assorted attachments
- One Ellis variable speed drill
- One Vishay 1011 strain indicators
- One Vishey P-3500 strain indicator
- Various Wykham Farrance dial gauges
- HP 34401A high-performance digital multimeter
- Wild total station survey instrument Model TC1600 c/w Wild GRE4 Data Collector, power supply, prisms and poles
- Nine automatic levels
- Ten Transits/Theodolites
- Trimble R3 GPS unit c/w Trimble Business Centre software
- Four Nikon Nivo Total Station instrument c/w tripods, prisms and poles

- Four Spectra precision laser levels
- Assorted standard surveying equipment

5. Hydraulics & Hydrology Lab (CB-0043, 99.1 m^2)

- Open channel flow apparatus (Siemonsen Mechanical Products)
- Centrifugal pump apparatus (Gilkes)
- Francis turbine apparatus (Gilkes)
- Flow visualization bench (Tecquipment)
- Friction loss in pipes circuit apparatus (Scott)
- Hydraulic benches
- Nozzle flow (Tecquipment), water jet, Venturi meter (Tecquipment), V-notch weirs, orifice plate, and floating body experiments are available
- Open channel flume
- Centrifugal pump test rig
- Francis turbine power plant
- Flow visualization bench
- Hydraulic benches (nozzle flow, jet impact, Venturi calibration, square and V-notch weirs, orifice calibration, pressure gauge calibration and floating body experiments are available)
- Friction loss in pipes, fluids circuit apparatus.
- Calcomp digitizing board (Model 9100) with IBM PC compatible computer, printer and software for digitizing
- Tilting bucket rain gauge and conical rain gauge
- Depth sounding (mechanical) apparatus
- Flow meters (pygmy and standard current meter)
- Water level/time recorder

6. Environmental Engineering Lab (CB-0031, 25.5 m^2)

- Microtox toxicity testing system with computer
- UV-vis Spectrophotometer, with computer and printer
- dissolved oxygen meter
- 2 pH/ mV/ISE benchtop meters
- conductivity meter
- analytical balance
- turbidimeter
- COD reactor
- anemometer
- temperature/humidity meter
- vacuum pump
- filtration manifold
- CST meter
- gravity flow standard lab oven
- desiccator

- 4 magnetic stirrers
- refrigerator
- 3 electronic pipetters
- TOC analyzer (placed in the instrumentation lab)
- one environmental chamber/walk in freezer (located in CB0043, room temperature to -40 °C)
- collimated UV device
- refrigerated circulator (chilling bath)
- 750 W ultrasonic processor
- ultrasonic bath

7. Machine Shop (Mechanical Engineering Machine Shop, CB-1016, 154.1 m²)

In addition to the above labs, Civil Engineering students have access to the Mechanical Engineering Machine Shop. These machine shops have a long history of providing valuable service to individuals and research groups in the production of prototype research and development work as well as construction of teaching aids.

Students, staff and faculty members in the Faculty of Engineering with a good working knowledge of machine tools and welding equipment are free to use the shop for manufacturing and repair works under the supervision of the technologist in charge. The users must follow posted safety rules. A senior technologist, who is also a licensed machinist, and two well-trained mechanical engineering technologists are available for technical and manual assistance if required. The three technologists have extensive experience in tool and die making, machining and metal cutting, welding (including aluminum), sheet metal work, and equipment repairs.

Appendix C: Computer Facilities

TSC Technology Facilities

The Technology Services Centre (TSC) brings together the skills, knowledge and technology to provide Academic and Administrative Computing, Information Services, Voice and Data Communications and Computing Services in the areas of learning and research. Our goal is to assist the University in fulfilling its Academic mission, and to provide the support and guidance necessary to enhance the effectiveness of the institution in all its' service offerings. With a team of over 30 highly trained and skilled individuals, the TSC remains committed to supporting and strengthening our students' academic careers by providing University-wide access to information and technology resources.

The Advanced Technology Academic Centre (ATAC) opened its doors in September 2003 at Lakehead University, Thunder Bay Campus equipping the University with a modern, high-tech instruction, research and learning facility. In addition to providing more classroom space for students from many faculties, the Centre houses research and teaching laboratories for technology-intensive courses in software engineering, electrical engineering, geographic information systems, and computer science. ATAC's state-of-the-art Technology Enhanced classroom environments have expanded distance education through greater access to video-conferencing and other distributed learning tools. The TSC client base, including students, faculty and staff, have access to the Computer Helpdesk located on the second floor of the ATAC and there are a number of kiosks distributed on the first floor of the building that provide Internet access for our users.

ATAC is home to the following Lakehead University departments, programs and facilities:

- Northern Ontario Medical School (NOSM)
- Technology Services Centre (TSC)
- Computer Science
- Electrical & Software Engineering
- Geographic Information Systems (GIS) Laboratories
- Multi-media Production Studio
- Part-Time Studies & Distance Education
- Robotics Engineering Laboratories
- Virtual Reality Lab

High Performance Research Computing

The High Performance Computing Centre makes its home in the ATAC. This centre offers large scale computing resources to facilitate research, discovery and innovation in all academic fields of study. The TSC staff provides support and expertise for researchers with the use of this leading edge technology and its' tools.

High-performance computing gives researchers in mathematics, engineering, computer science, finance, chemistry and health sciences, as well as any other discipline that engages in computer modeling, the advantage of having large computing power to crunch the numbers.

Lakehead is a member of SHARCNET (http://www.sharcnet.ca/), a consortium of colleges and universities with high-performance computers across south-central Ontario who have pooled their resources to create The Shared Hierarchical Academic Research Computing Network (SHARCNET).

As a member of SHARCNET, Lakehead's high-performance computing capability increases from its current level of 132 CPUs to over 3,000 CPUs, and gives researchers unlimited access to resources and support in the form of peer mentors, research collaborations, and software developers.

Come the fall of 2010, the TSC will be commissioning another on-campus Data Centre to provide full redundancy for its centralized computing and storage resources.

Virtual Reality

The Lakehead University Virtual Reality Environment (LUVRE) managed by the TSC, boasts the latest in state-of-the-art imaging and processing technology, truly establishing Lakehead as a leader in Virtual Reality instruction and research. High performance computers (HPC) drive the video display, rendering and complex computations. Coupled with high refresh rate projectors and a curved laser calibrated screen, these robust technologies result in a highly realistic and sophisticated interactive simulation environment that is useful for understanding spatial dynamics as well as relationships among objects, people and places.

The benefits of this system to industry, education and health care include the ability to visualize and interact with models and processes without a safety risk or financial impracticality in addition to relinquishing the need to develop/acquire actual physical models.

Virtual Reality - A Unique Learning Tool

LUVRE offers faculty and students unique experiences that are consistent with successful instructional strategies: hands-on learning, group projects and discussions, simulations and concept visualization. The virtual reality learning environment is experiential and intuitive; it is a shared information context that offers unique interactivity and can be configured for individual learning and performance styles.

LUVRE's Practical Applications

With the ability to perform highly realistic simulations of engineering, industrial planning, GIS/mapping, medical and molecular modeling, LUVRE is only limited by one's imagination. It is a valuable tool that empowers Lakehead University to engage local, national and international companies interested in the use of cost-saving VR techniques in businesses ranging from pulp paper production to health care research to mining operations.

The VR Technology

The LUVRE System utilizes:

- BARCO DLP projectors that operate at the highest possible refresh rate
- Infrared, stereoscopic LCD, CrystalEyes - shutter glasses used for Stereo 3D imaging
- A curved laser calibrated screen

- Surround sound audio system to support professional software applications used in product visualization and simulation

Telephony and the Network

Lakehead University utilizes fully converged network for data, voice and video communications. The backbone of the network is built on a redundant multi gigabit fiber optic network comprising of multiple Layer 3 routable switches, over 40 wiring closets and 8000 plus Ethernet ports. TSC supports 2600 voice over IP phones, Video Conference Units, security cameras, environmental controls, computers, printers and Servers which are all running on the same IP infrastructure.

The Teaching Environment

The Multimedia Service Unit is committed to providing a wide range of technological communication services across campus including the Orillia campus. All classrooms in the ATAC are equipped with multi-media podiums, complete with a touch panel. Furthermore each classroom boasts an in-room PC with a flat panel monitor, two USB ports, CDRom and floppy drives, Internet connects, IP telephone with speaker, laptop dock (video, audio, Internet and power), VCR player, DVD player, and document camera. Individual network ports have been installed in the classrooms for student connectivity. The teaching labs in the ATAC are outfitted with instructor PC's and multimedia equipment as well.

Video Conferencing and teleconferencing technology is available in the three (3) large theatres as well as in multiple designated V/C rooms. A total of twelve rooms (12) in the ATAC are available for video streaming with three (3) other rooms on campus residing in the Nursing building and Regional Centre. Video and Audio digital production is available along with media conversion and linear and non linear editing. Additionally, mobile conferencing units can be deployed anywhere on campus.

General Classroom Details

All computer classrooms on both Campuses are networked. The computers in these rooms have a full range of Internet services including E-mail, web browsers, terminal emulation, FTP etc. They are also equipped with the appropriate applications such as word processors, spreadsheets, database programs, statistical analysis software, compilers and special purpose software. General student computer labs on both campuses are also available. These general student labs are never used as instruction facilities, as they are dedicated for student use at all times.

Students must have an account on the appropriate server before any computer can be used. Accounts are created automatically from student registration information. A Lakehead Web-mail account is also set up for every student at this time. Lakehead's e-mail service is provided by Google as part of a new partnership developed in November of 2006. The e-mail accounts are perpetual, never deleted and may be used by students as a personal account after graduation.

Printing Services

Printing facilities are provided via central and satellite laser printers in both monochrome and colour. The printers are located throughout the ATAC building and

other locations on Campus including large scale colour plotting are provided student use.

A networked database controls Lakehead's printing services. Students are given an initial credit upon registration, then they deposit to their account as required in order to continue using these printing services. In addition to the printing services, scanners can be found at various locations on campus for student use.

Computer Classroom Bookings

The Technology Enabled Classrooms are booked for course use through the Registrar's Scheduling Office. This is necessary to ensure that timetable requirements are met. Consultation with the TSC staff is also necessary to ensure that all of the software and operating systems in the classroom match the course requirements. There are multiple software applications installed in each classroom and there is a certain degree of coordination required in order to service all the needs of each Technology Enabled Classroom. Data projectors are provided in all ATAC TSC computer classrooms and by request from the Audio-Visual unit of the TSC for other computer labs.

Computer Classroom Usage

Computer classrooms under the supervision of TSC are available 24 hours a day for student use during the Fall and Winter Terms. This is subject to prior class bookings. Students not only use these labs to complete course assignments but also use the labs for electronic mail, resumes, projects and personal recreation on the Internet.

Computer classrooms are used for public and high school tours, university-sponsored conferences and staff training.

Classroom Hardware Details

The majority of computer classrooms contain IBM-compatible computers. The following table shows room location, number of computers, operating system and type of computer.

Room Location	Number of Computers	Operating System	Type of Computer
BB1066	20	Windows	Thin Clients
CB1003	24	Windows	Desktops
CB1004 *	18	Windows	Desktops
SB1027	30	Windows	Thin Clients
Agora	12	Windows	Thin Clients (Kiosks)

BL2001	38	Windows	Mac
ATAC 1st Floor	30	Windows	Thin Clients (Kiosks)
AT3001	60	Windows	Desktops
AT3002	60	Windows	Desktops
AT3003	20	Windows	Desktops
AT3010-GIS	20	Windows	Desktops
AT3009-GIS	20	Windows	Desktops

Classroom Software Details

The software available to these systems is dependent upon the operating system. In the main teaching labs, the current standard software available includes:

- SPSS
- Microsoft Office Suite including Word, Excel, Access, FrontPage, PowerPoint, Project, Visio
- Microsoft Visual Studio.Net
- Secure SFTP / Telnet (SSH) / Putty / WinZip
- Adobe Photoshop
- ESRI campus site license for ArcGIS suite of products
- In AT4019, engineering software served from a Solaris Server, includes:
- Hysis
- AutoCAD with Mechanical Desktop
- Ram Scheduler
- Lindo
- Tutsim

Sun Workstation Classrooms

Room Location	Number of Computers	Operating System	Type of Computer
AT4019	54	Solaris 9	Sun Blade 150

The workstations connect to a Sun Solaris server, the Engineering Sun Solaris Server *Sunshine* and the SGI Origin Super Computer, *Giant*. Applications available on *Sleet* include Matlab, Ansys and SPSS along with programming languages such as

Lisp, C and Fortran. *Giant* supports SAS, parallel programming, Virtual Reality and other custom applications.

Other Resources

Graphics Lab

A graphics lab with eight SGI 330 workstations, an HP DesignJet 3800 printer and a SGI 1400 server is available for GIS research. The main software packages in use are ArcView and ArcInfo.

Residence

Lakehead University Residences are fully wired with network ports available in every room and VoIP telephony.

Tech Fund

The Lakehead University Student Union (LUSU) has a Tech Fund which also provides additional computer resources for students. General use computer labs have been added through this fund including two labs in the University Library, a smaller lab in the Education Library and another in Visual Arts and Music.

Scanning Stations

Colour scanners are available to students in the main printer room in the Braun Building and in two Library computer labs. Digital still cameras, a digital video camera, laptops and data projectors can be booked by students through the Audio-Visual unit of TSC.

Internet Carousels

The ATAC building has an IBM thin client solution for the Internet Carousel system on the first floor and in the Agora. A SunRay system is used for Internet Carousels in the Centennial Building and outside the main cafeteria.

J. Terry Young
Manager, Technology Services
Lakehead University

Appendix D: Draft Calendar Entry (version dated January 21, 2013)

(This appendix will be finalized following approval by the Senate Academic - Quality Assurance Committee)

Professor and Dean: D. Barnett

MSc (CIVIL ENGINEERING)

Graduate Coordinator: Y. Gong

Core: Master's Thesis Supervisory

W. Gao
A. Gillies
Y. Gong
J. He
B. Kjartanson
E. Mohamedelhassan
U. Panu
J. Pernia
O. Salem

MSc IN CIVIL ENGINEERING

The MSc in Civil Engineering satisfies the demand in academia and industry for highly-qualified personnel in the field of Civil Engineering. The program is directed to graduates from the existing undergraduate program in Civil Engineering at Lakehead University and graduates from undergraduate programs at other universities. The program fosters independent research abilities of students. These objectives are achieved through a combination of course work and research towards the completion of a thesis.

ADMISSION REQUIREMENTS

Candidates are accepted under the Admission Requirements of the Faculty of Graduate Studies Master's Regulations provided that the requirements of the Faculty of Engineering are also satisfied.

To be considered for admission to the MSc program in Civil Engineering, the applicant must normally hold a Bachelor's Degree in Civil Engineering or other equivalent four-year programs, in addition to all other general admission requirements of the University.

A make-up period of study, as recommended by the Engineering Graduate Studies Committee, may be required where the student is deficient in background undergraduate level courses. Proficiency in the English language is required. Meeting

the minimum requirements does not necessarily lead to automatic admission, but depends on the availability of places in the program and on an assessment by the Engineering Graduate Studies Committee of the applicant's aptitude for graduate studies and research.

The application deadline is **February 1**. Late applications will be considered for admission, but may not be eligible for funding.

ACADEMIC REGULATIONS

In addition to the Faculty of Graduate Studies Master's Regulations of this calendar, Engineering students are also bound by the regulations listed below.

Course Substitution

For MSc in Civil Engineering, one of the four half-courses of the program may be taken from another existing graduate program at Lakehead University. A student can take only one graduate reading course under Engineering 5691: Advanced Topics in Civil Engineering to be credited as a half-course. One of the four half-courses may be a senior undergraduate half-course that has not previously been taken. The student's choice of courses must be approved by the graduate supervisor and the Graduate Program Coordinator.

Minimum Satisfactory Academic Standing

All graduate students must obtain a minimum mark of 70% (B) in each half-course. A score of less than 70% will constitute a failure. A failed half-course may be repeated or replaced by another course specified by the supervisor only once. Any students with more than one half-course failure on his/her record must withdraw from the program.

Thesis Supervision and Examination

The student will be guided by a thesis supervisor and a supervisory committee to be established by the end of the first term after enrolment. A research thesis topic should be submitted to the student's thesis supervisor by the end of the second term of studies. When completed, the thesis will be examined under university regulations (see Faculty of Graduate Studies Master's Regulations).

MSc PROGRAM IN CIVIL ENGINEERING

The requirements for the MSc in Civil Engineering (total 5 FCEs) are:

(a) four half-courses (2 FCEs), of which at least three must be chosen from the graduate courses in Civil Engineering as specified below
(b) the graduate seminar, Engineering 5891 (carries 0.5 FCE credit weight)
(c) the graduate thesis, Engineering 5901 (9901) (carries 2.5 FCE credit weight)

Graduate Courses:

Engineering 5190: Modeling Techniques in Water Resources

Engineering 5191: Stochastic and Statistical Methods in Water Resources
Engineering 5151: Geoenviromental Engineering
Engineering 5451: Physicochemical Treatment Processes
Engineering 5390: Computer Applications in Traffic Engineering
Engineering 5391: Highway Safety
Engineering 5590: Advanced Foundation Engineering
Engineering 5591: Geomaterials Properties and Behaviour
Engineering 5592: Finite Element Analysis for Civil Engineering Applications
Engineering 5593: Structural Design for Fire Resistance
Engineering 5594: Advanced Structural Steel Design
Engineering 5595: Structural Dynamics and Earthquake Engineering
Engineering 5691: Advanced Topics in Civil Engineering

DESCRIPTION OF THE GRADUATE COURSES

Engineering 5190
Modeling Techniques in Water Resources

Credit Weight:
0.5

Description:
Dimensionless formulation of natural laws and simulation theory; theoretical principles in the formulations of models; model construction techniques, calibration and validation procedures; hands on experience with numerical models; case studies with design for minimum environmental impacts.

Offering:
3-0; or 3-0

Engineering 5191
Stochastic and Statistical Methods in Water Resources

Credit Weight:
0.5

Description:
Probability distribution, correlation analysis, trend analysis, regression analysis, hypotheses testing, uncertainty analysis, and autoregressive moving average method for modeling time series.

Offering:
3-0; or 3-0

Engineering 5151
Geoenviromental Engineering

Credit Weight:
0.5

Description:
Physical and hydrogeological properties of unsaturated and saturated porous media and engineered barrier materials; capillary barriers; contaminant fate and transport; geoenvironmental site characterization; groundwater monitoring and slug testing; design, construction and performance of landfill containment systems; contaminated site remediation methods.

Offering:
3-0; or 3-0

Engineering 5451
Physicochemical Treatment Processes

Credit Weight:
0.5

Description:
Theory and design of chemical and physical processes utilized in the treatment of water and wastewater. Sedimentation; flotation; coagulation; precipitation; filtration; membrane separations; disinfection; ion exchange; adsorption; gas transfer.

Offering:
3-0; or 3-0

Engineering 5390
Computer Applications in Traffic Engineering

Credit Weight:
0.5

Description:
Transportation software such as Highway Capacity Software and Synchro-Simtraffic, traffic stream characteristics, traffic flow models, intersection analysis, capacity analysis, freeway management, data collection methods and parking studies

Offering:
3-0; or 3-0

Engineering 5391
Highway Safety

Credit Weight:
0.5

Description:

Transportation safety studies, accident data analysis, traffic safety control devices, special population safety, highway conflict studies, and accident reconstruction

Offering:
3-0; or 3-0

Engineering 5590
Advanced Foundation Engineering

Credit Weight:
0.5

Description:
Site exploration for foundations and retaining structures; load capacity and settlement of shallow and deep foundations; deep foundations under lateral loading; sheet pile walls, ground anchors and soil nails; ground improvement and modification techniques.

Offering:
3-0; or 3-0

Engineering 5591
Geomaterials Properties and Behaviour

Credit Weight:
0.5

Description:
Basic geotechnical characteristics, properties and behaviour of soils and rocks; laboratory compressibility and shear strength testing; stress paths; geotechnical site characterization; geotechnical instrumentation and field monitoring; constitutive models of soil and rock behaviour; stability of slopes.

Offering:
3-0; or 3-0

Engineering 5592
Finite Element Analysis for Civil Engineering Applications

Credit Weight:
0.5

Description:
Direct stiffness method; elements of truss, beam, and frame; plane stress and plane strain elements; principle of minimum potential energy; virtual work principle; Galerkin's residual method; axisymmetric elements; plate bending elements; isoparametric formulation; three-dimensional stress analysis; thermal stress analysis; software application.

Offering:
3-0; or 3-0

Engineering 5593
Structural Design for Fire Resistance

Credit Weight:
0.5

Description:
Fire safety engineering; room fire development process; compartment fire dynamics; concept of fire severity; fire-resistance tests and ratings; mechanical and thermal properties of different construction materials in fire; heat transfer analysis; fire protection systems; fire-resistance design of structural members and assemblies made of steel, concrete and timber; performance-based approach for building fire safety design.

Offering:
3-0; or 3-0

Engineering 5594
Advanced Structural Steel Design

Credit Weight:
0.5

Description:
Stability theory; inelastic column buckling; beam-columns; frame stability; lateral-torsional buckling; bracing; semi-rigid connections and modeling; plastic analysis in connections; uniform force method.

Offering:
3-0; or 3-0

Engineering 5595
Structural Dynamics and Earthquake Engineering

Credit Weight:
0.5

Description:
Building models for seismic design; vibrations of single and multiple degree of freedom systems; damping; vibration frequencies and modes; response and design spectra; modal response history and spectrum analyses; plastic hinges and mechanisms; capacity design.

Offering:
3-0; or 3-0

Engineering 5691
Advanced Topics in Civil Engineering

Credit Weight:
0.5

Description:
Current developments and specialized topics in Civil Engineering.

Special Topic:
Y

Offering:
3-0; or 3-0;

Engineering 5891
Seminar Civil Engineering

Credit Weight:
0.5

Description:
An ordered and critical exposition of the literature on an appropriate topic in mechanical engineering.

Offering:
1-0; or 1-0

Appendix E: Student Learner Outcomes of the Graduate Courses

Engineering 5190
Modeling Techniques in Water Resources

Student Leaner Outcomes
1) Develop the ability to interpret and analyze basic principles of modeling techniques such as physical models, analog models, and mathematical models in water resources systems. (Links to Program Learner Outcomes: a)
2) Develop the ability to discuss common modeling techniques in hydrology and hydraulics. (Links to Program Learner Outcomes: a, e)
3) Develop the ability to explain the significance of mathematical, analog, and physical models in water resources systems. (Links to Program Learner Outcomes: a, g)
4) Develop the ability to identify, select, and design data input structures for input into hydrology and hydraulic models computational analysis of water resources systems. (Links to Program Learner Outcomes: a, d)
5) Develop the ability to identify flow profiles in gradually varied flow and compute flow profiles in man-made and natural streams using HEC-RAS (HEC-2) model. (Links to Program Learner Outcomes: a, e)
6) Develop the ability to conduct and analyze flood frequency analysis at a single and multiple stations (regional analysis) using the consolidated flood frequency model. (Links to Program Learner Outcomes: a)
7) Develop the ability to cconduct and analyse hydrographs using HEC-HMS (HEC-1) model in watersheds, route hydrograph for flood warning systems and conduct flood plain mapping, and urbanization effects on stream flow hydrographs. (Links to Program Learner Outcomes: a, d)
8) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)
9) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively, in both written and oral language, related to assignments and term project. (Links to Program Learner Outcomes: g)

Engineering 5191
Stochastic and Statistical Methods in Water Resources

Student Learner Outcomes
1) Develop the ability to apply basic methods of mathematical statistics and probability theory to characterize data. (Links to Program Learner Outcomes: a, e)
2) Develop the ability to use goodness of fit tests to identify a distributional model to a data set. (Links to Program Learner Outcomes: a, e)
3) Develop the ability to investigate relationship/association between variables through both parametric and non-parametric methods. (Links to Program Learner Outcomes: a, e)
4) Develop the ability to conduct simple and multiple linear regression analysis. (Links to Program Learner Outcomes: a, e)

5) Develop the ability to conduct parametric and nonparametric trend analysis. (Links to Program Learner Outcomes: a, e)
6) Develop the ability to perform hypotheses testing. (Links to Program Learner Outcomes: a, e)
7) Develop the ability to perform uncertainty analysis. (Links to Program Learner Outcomes: a, e)
8) Develop the ability to explain and apply autoregressive moving average method. (Links to Program Learner Outcomes: a, e)
9) Demonstrate the ability to apply the above techniques stated in outcomes 1 to 8 to model water quantity and quality. (Links to Program Learner Outcomes: a, d, e)
10) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)
11) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively related to assignments and term project. (Links to Program Learner Outcomes: g)

Engineering 5151
Geoenvironmental Engineering

Student Learner Outcomes
1) Demonstrate the ability to discuss and analyze physical and hydrogeological properties of unsaturated and saturated porous media and engineered barrier materials. (Links to Program Learner Outcomes: a, e)
2) Demonstrate the ability to discuss the capillary barrier effect and analyze and design capillary barrier systems for moisture retaining covers. (Links to Program Learner Outcomes: a, e)
3) Demonstrate the ability to discuss and analyze contaminant fate and transport processes and analyze and explain one-dimensional contaminant transport through laboratory columns, field engineered barriers and aquifer systems and chemical effects on clayey soil hydraulic conductivity. (Links to Program Learner Outcomes: a, e)
4) Demonstrate the ability to discuss geoenvironmental site characterization and select and apply methodologies and technologies to design and conduct a geoenvironmental site characterization. (Links to Program Learner Outcomes: a, e)
5) Demonstrate the ability to discuss groundwater monitoring and slug testing of monitoring wells and analyze slug test data. (Links to Program Learner Outcomes: a, e)
6) Demonstrate the ability to discuss and analyze the design, construction and performance of landfill containment systems. (Links to Program Learner Outcomes: a, e)
7) Demonstrate the ability to discuss and compare in situ and ex situ contaminated site remediation methods. (Links to Program Learner Outcomes: a, e)
8) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)

9) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively related to assignments and term project. (Links to Program Learner Outcomes: g)

Engineering 5451
Physicochemical Treatment Processes

Student Learner Outcomes
1) Demonstrate the ability to analyze the factors that influence selection of a water treatment scheme. (Links to Program Learner Outcomes: a, e)
2) Demonstrate the ability to explain the mechanisms of destabilization of colloidal particles in coagulation process and develop the ability to evaluate and design coagulation/flocculation processes. (Links to Program Learner Outcomes: a, d, e)
3) Develop the ability to discuss sedimentation theory and select and design sedimentation processes. (Links to Program Learner Outcomes: a, e)
4) Demonstrate the ability to explain mechanism of filtration and design granular bed filters. (Links to Program Learner Outcomes: a, d, e)
5) Demonstrate the ability to discuss types of membrane processes and design considerations. (Links to Program Learner Outcomes: a, e)
6) Demonstrate the ability to select and design lime-soda ash softening processes. (Links to Program Learner Outcomes: a, d, e)
7) Demonstrate the ability to discuss basic chemistry and compare various disinfection methods and disinfection byproducts. (Links to Program Learner Outcomes: a, e)
8) Demonstrate the ability to explain adsorption equilibrium, mechanisms of activated carbon adsorption of organic compounds. (Links to Program Learner Outcomes: a, e)
9) Demonstrate the ability to explain theory of gas transfer and identify aeration/air stripping systems used in water and wastewater treatment. (Links to Program Learner Outcomes: a, e)
10) Demonstrate the ability to design a water/wastewater treatment system based on given requirements. (Links to Program Learner Outcomes: a, d, e)
11) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)
12) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively related to assignments and term project. (Links to Program Learner Outcomes: g)

Engineering 5390
Computer Applications in Traffic Engineering

Student Leaner Outcomes
1) Develop the ability to analyze traffic stream characteristics such as traffic volume, speed and density and to use them in the transportation software recognizing their application limitations. (Links to Program Learner Outcomes: a, e)
2) Demonstrate the ability to understand and analyze traffic flow models in order to apply the software. (Links to Program Learner Outcomes: a, e)

3) Develop the ability to describe and determine the necessary factors required for the use of the transportation software. (Links to Program Learner Outcomes: a, e)
4) Demonstrate the ability to perform intersection analysis with and without the use of the transportation software. (Links to Program Learner Outcomes: a, e)
5) Develop the ability to discuss and to analyze results from the intersection analysis. (Links to Program Learner Outcomes: a, c, d, e)
6) Demonstrate the ability to perform capacity analysis of different roadways with and without transportation software. (Links to Program Learner Outcomes: a, e)
7) Develop the ability to discuss and to analyze results from the capacity analysis. (Links to Program Learner Outcomes: a, c, d, e)
8) Develop the ability to explain and apply freeway management. (Links to Program Learner Outcomes: a, e)
9) Develop the ability to perform parking studies. (Links to Program Learner Outcomes: a, e)
10) Develop the ability to explain and apply data collection methods. (Links to Program Learner Outcomes: a, e)
11) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)
12) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively related to assignments and term project. (Links to Program Learner Outcomes: g)

Engineering 5391
Highway Safety

Student Leaner Outcomes
1) Develop the ability to critically evaluate existing literature in the specific field of highway safety and demonstrate systematic understanding of knowledge with the required depth and breadth. (Links to Program Learner Outcomes: a)
2) Develop the ability to perform highway safety studies in general and in specific situations depending on the roadway system. (Links to Program Learner Outcomes: a, e)
3) Develop the ability to analyze accident data in order to determine the safety problem and possible improvements for the roadway. (Links to Program Learner Outcomes: a, e)
4) Demonstrate the ability to explain and apply safety considerations for special population groups. (Links to Program Learner Outcomes: a, d, e)
5) Demonstrate the ability to explain and apply traffic safety control devices according to the specific roadway situation. (Links to Program Learner Outcomes: a, d, e)
6) Demonstrate the ability to explain and apply the adequate procedure for highway conflict analysis. (Links to Program Learner Outcomes: a, e)
7) Develop the ability to apply adequate techniques for accident reconstruction. (Links to Program Learner Outcomes: a, e)
8) Develop the ability to conduct independent term project and show competence in the research process and demonstrate advanced research and scholarship within

the highway safety area using pertinent mathematical, scientific, and engineering concepts. (Links to Program Learner Outcomes: a, c, d, e)
9) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)
10) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively related to assignments and term project. (Links to Program Learner Outcomes: g)

Engineering 5590
Advanced Foundation Engineering

Student Learner Outcomes
1) Demonstrate the ability to design and analyze site exploration components and select the appropriate type of foundation, shallow or deep. (Links to Program Learner Outcomes: a, e)
2) Demonstrate the ability to design and analyze the performance of shallow and deep foundation systems and evaluate the stress under the foundation and the corresponding magnitude of settlement using elastic theory and numerical modelling. (Links to Program Learner Outcomes: a, e)
3) Demonstrate the ability to discuss and analyze the ultimate and allowable load capacity of deep foundation elements from static and dynamic load tests and use the results to determine the strength parameters of the soil, the toe-bearing resistance and side friction resistance. (Links to Program Learner Outcomes: a, e)
4) Demonstrate the ability to discuss the response of deep foundation elements to lateral loads and to evaluate and analyze the load capacity and deformation of the foundation element using experimental, analytical and numerical methods. (Links to Program Learner Outcomes: a, e)
5) Demonstrate the ability to evaluate and analyze the design and performance of sheet piles walls, ground anchors and soil nails. (Links to Program Learner Outcomes: a, e)
6) Demonstrate ability to discuss and compare ground improvement and soil modification techniques to increase the strength properties and/or decreases the compressibility of weak/soft soils. (Links to Program Learner Outcomes: a, d, e)
7) Demonstrate ability to evaluate and compare the load capacity, performance and/or stability of foundation elements and retaining structures after soil improvement/ modification. (Links to Program Learner Outcomes: a, d, e)
8) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)
9) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively related to assignments and term project. (Links to Program Learner Outcomes: g)

Engineering 5591
Geomaterials Properties and Behaviour

Student Learner Outcomes

1) Demonstrate the ability to discuss and analyze basic geotechnical characteristics, properties and behaviour of soils and rocks including compressibility and shear strength. (Links to Program Learner Outcomes: a, e)
2) Demonstrate the ability to discuss and analyze laboratory compressibility and shear strength testing for soils and rocks. (Links to Program Learner Outcomes: a, e)
3) Demonstrate the ability to discuss, interpret, analyze and produce stress paths for field loading conditions and laboratory tests. (Links to Program Learner Outcomes: a, e)
4) Demonstrate the ability to discuss geotechnical site characterization equipment and methods and to analyze and interpret the results of geotechnical site characterization tests. (Links to Program Learner Outcomes: a, e)
5) Demonstrate the ability to discuss, interpret and analyze the results of geotechnical instrumentation for monitoring field performance and to plan a geotechnical instrumentation monitoring program for a given site. (Links to Program Learner Outcomes: a, e)
6) Demonstrate the ability to discuss, analyze and apply constitutive models of soil and rock behaviour. (Links to Program Learner Outcomes: a, d, e)
7) Demonstrate the ability to discuss and analyze the stability of slopes. (Links to Program Learner Outcomes: a, d, e)
8) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)
9) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively related to assignments and term project. (Links to Program Learner Outcomes: g)

Engineering 5592

Finite Element Analysis for Civil Engineering Applications

Student Learner Outcomes

1) Develop the ability to compare the properties of different types of finite elements and recognize their application limitations. (Links to Program Learner Outcomes: a, e)
2) Demonstrate the ability to employ different finite element methods in modeling various structural systems. (Links to Program Learner Outcomes: a, e)
3) Develop the ability to formulate truss, beam, frame and grid finite element equations. (Links to Program Learner Outcomes: a, e)
4) Develop the ability to compare the outcomes of plane stress and plane strain stiffness equations. (Links to Program Learner Outcomes: a, e)
5) Develop the ability to discuss numerical solution of non-linear equations. (Links to Program Learner Outcomes: a, e)
6) Demonstrate the ability to conduct numerical simulations using an existing finite-element software package for the analysis of different structural systems. (Links to Program Learner Outcomes: a, d, e)
7) Develop the ability to conduct three-dimensional stress analysis and thermal stress analysis using numerical modelling. (Links to Program Learner Outcomes: a, d, e)

8) Develop the ability to conduct independent term project and show competence in the research process within the area of numerical modelling (Links to Program Learner Outcomes: a, d, e)
9) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)
10) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively related to assignments and term project. (Links to Program Learner Outcomes: g)

Engineering 5593
Structural Design for Fire Resistance

Student Learner Outcomes
1) Develop the ability to critically evaluate existing literature in the field of fire safety engineering and demonstrate systematic understanding of knowledge with the required depth and breadth. (Links to Program Learner Outcomes: a)
2) Develop a sound knowledge of fire development, compartment fire behaviour and concept of fire severity. (Links to Program Learner Outcomes: a, e)
3) Develop the ability to explain the response of different structural elements and assemblies when exposed to fire. (Links to Program Learner Outcomes: a, e)
4) Develop the ability to analyze heat transfer problems such as conduction, convection and radiation. (Links to Program Learner Outcomes: a, e)
5) Develop the ability to conduct complete fire design for structural elements and assemblies made of steel, concrete and timber. (Links to Program Learner Outcomes: a, e)
6) Demonstrate a sufficient understanding of the performance-based approach for building fire safety design, and to employ this approach to develop simple fire design solutions for structural elements. (Links to Program Learner Outcomes: a, d, e)
7) Develop a sound knowledge of standard fire testing, and the ability to analyse fire-resistance test measurements. (Links to Program Learner Outcomes: a, e)
8) Develop the ability to conduct independent term project and show competence in the research process within the area of fire safety engineering (Links to Program Learner Outcomes: a, d, e)
9) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)
10) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively related to assignments and term project. (Links to Program Learner Outcomes: g)

Engineering 5594
Advanced Structural Steel Design

Student Learner Outcomes

1) Develop the ability to discuss various instability phenomenon and solution methods and recognize their application limitations. (Links to Program Learner Outcomes: a, e)
2) Develop the ability to apply the tangent modulus, reduced modulus, and Shanley models to obtain the load-carrying capacity of an inelastic column and recognize their application limitations. (Links to Program Learner Outcomes: a, e)
3) Develop the ability to apply elastic and inelastic beam-column theories to obtain the load-carrying capacity of a beam-column and recognize their application limitations. (Links to Program Learner Outcomes: a, e)
4) Demonstrate the ability to describe frame instability failure and discuss various techniques for solutions. (Links to Program Learner Outcomes: a, e)
5) Develop the ability to derive differential equations for solving the elastic lateral-torsional buckling of beams. (Links to Program Learner Outcomes: a, e)
6) Develop the ability to discuss various member bracing techniques and solution methods. (Links to Program Learner Outcomes: a, e)
7) Develop the ability to analyze frameworks with semi-rigid connections. (Links to Program Learner Outcomes: a, d, e)
8) Develop the ability to apply plastic theory in the analysis and design of connections. (Links to Program Learner Outcomes: a, d, e)
9) Demonstrate the ability to design a bracing connection using uniform force method. (Links to Program Learner Outcomes: a, d, e)
10) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)
11) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively related to assignments and term project. (Links to Program Learner Outcomes: g)

Engineering 5595
Structural Dynamics and Earthquake Engineering

Student Learner Outcomes
1) Develop the ability to model building structures for seismic design and recognize the application limitations. (Links to Program Learner Outcomes: a, e)
2) Develop the ability to derive the governing differential equations for the vibration problems of single and multiple degree of freedom systems and discuss the solution techniques. (Links to Program Learner Outcomes: a, e)
3) Demonstrate the ability to discuss various damping models and utilize various techniques to obtain the damping property of a structure. (Links to Program Learner Outcomes: a, e)
4) Develop the ability to analyze vibration periods and vibration modes of a multi-degree of freedom system. (Links to Program Learner Outcomes: a, e)
5) Demonstrate the ability to obtain the response spectrum for an earthquake ground motion and discuss the construction of a design spectrum. (Links to Program Learner Outcomes: a, e)

6) Demonstrate the ability to analyse a structure using modal response history analysis and modal response spectrum analysis. (Links to Program Learner Outcomes: a, e)
7) Develop the ability to conduct plastic analysis of beams and low-rise frames. (Links to Program Learner Outcomes: a, e)
8) Develop the ability to conduct seismic design of a building structure according to capacity design principle. (Links to Program Learner Outcomes: a, d, e)
9) Demonstrate personal responsibility and accountability in conducting the related assignments and term project. (Links to Program Learner Outcomes: f)
10) Demonstrate the ability to communicate ideas, issues and conclusions clearly and effectively related to assignments and term project. (Links to Program Learner Outcomes: g)

Engineering 5691
Advanced Topics in Civil Engineering

It is a reading course, and the subject is prepared by an individual professor in Civil Engineering. But the course Student Learner Outcomes must be aligned with the Program Learning Outcomes and the Graduate Degree Level Expectations. (Links to Program Learner Outcomes: a, d, e, f, g)

Engineering 5891
Seminar Civil Engineering

Student Learner Outcomes
1) Demonstrate the ability to perform comprehensive literature survey in the related research field. (Links to Program Learner Outcomes: a)
2) Demonstrate the ability of systematic understanding of knowledge in the related research area with the required depth and breadth. (Links to Program Learner Outcomes: a, e)
3) Demonstrate the ability to recognize current problems in the field of research and effectively explain the proposed research methodologies to be used to tackle the problems in the research project. (Links to Program Learner Outcomes: b, e, h)
4) Demonstrate the ability to provide a clear, complete and scientifically-accurate presentation to an audience of peers and experts constituting his/her thesis committee. (Links to Program Learner Outcomes: g)

Appendix F: General Graduate Studies Regulations
(As of January 21, 2013, revisions to these regulations are currently in progress)

FACULTY OF GRADUATE STUDIES

GRADUATE PROGRAMS

Dean of Graduate Studies
Dr. T. Philip Hicks

The University offers programs leading to the following degrees:
Master of Arts
Master of Business Administration
Master of Education
Master of Environmental Studies
Master of Forestry
Master of Science
Master of Science in Engineering
Master of Science in Forestry
Master of Science in Management
Master of Public Health
Master of Social Work
Doctor of Philosophy in Biotechnology
Doctor of Philosophy in Clinical Psychology
Joint Doctor of Philosophy in Educational Studies
Doctor of Philosophy in Forest Sciences

The University also offers collaborative programs with the following specializations:
Specialization in Gerontology
Specialization in Women's Studies

The University also offers programs which include the following graduate diploma:
Health Services and Policy Research

Not all courses listed in the Calendar are offered every year. Supplementary information regarding course offerings and course instructors is available from the Office of the Registrar and posted in the online Course Timetable.

Introduction to the Faculty of Graduate Studies

Responsibility for graduate studies resides with the Senate of the University. The Senate is advised on graduate matters by the Faculty of Graduate Studies Council. This Council is administered through the Office of Graduate Studies. It is the responsibility of this Council, through its Chair, to provide leadership in all matters pertaining to graduate studies.

Graduate Programs

The University offers courses of study leading to the following graduate degrees:
- Master of Arts (MA) in Clinical Psychology, Economics, English, History, Mathematical Sciences, Sociology;
- Master of Science (Msc) in Biology, Chemistry, Computer Science, Experimental Psychology, Geology, Kinesiology, Mathematical Sciences, Physics;
- Master of Education (MEd) in Educational Studies;
- Master of Science in Engineering (MScEng) in Control Engineering, Electrical and Computer Engineering, Environmental Engineering;
- Master of Environmental Studies (MES) in Nature-Based Recreation and Tourism, Northern Environments and Cultures;
- Master of Forestry (MF)
- Master of Science in Forestry (MScF);
- Master of Social Work (MSW)
- Master of Public Health (MPH)
- Master of Business Administration (MBA)
- Master of Science in Management (MSc(Mgt))
- Doctor of Philosophy (PhD) in Biotechnology, Clinical Psychology, Educational Studies, Forest Sciences.

Collaborative Programs

- Specialization in Gerontology (Education, Kinesiology, Psychology, Social Work, Sociology)
- Specialization in Women's Studies (Education, English, History, Psychology, Public Health, Social Work, Sociology)

To be accepted into a Collaborative Program, students must first be admitted to the master's program of a collaborating academic unit.

Graduate Diploma

-Health Services and Policy Research

The Graduate Diploma in Health Services and Policy Research is offered in conjunction with a master's or doctoral degree (Economics, Public Health, Social Work, Sociology).

Master's Regulations

A graduate student is governed by the general University Regulations section of this Calendar as well as the following regulations, which are specific to graduate students.

GENERAL ADMISSION REQUIREMENTS

Application for admission to a graduate program must be made to the Office of Graduate Studies, Lakehead University by the deadline date of **February 1**. Late applications may be considered for admission, but may not be considered for funding.

Applicants for admission must be graduates of a recognized university, college or institute, and show evidence of scholarly achievement. Except where otherwise stated in the Admission Requirements of a particular program, degree students must have a four year bachelor's degree or its equivalent with at least second class standing (B) based on their last 20 half courses or equivalent.

An applicant holding a degree other than one in the discipline area to which admission is sought will be considered on the basis of courses taken and academic standing. A Qualifying Year at the undergraduate level may be required to meet the admission standards. Courses taken as part of a Qualifying Year can not be used as credit towards a graduate degree.

Applicants applying from a university other than Lakehead University must forward official transcripts of their university record and may be required to take an examination, such as the Graduate Record Examination (GRE).

Meeting the minimum requirements does not necessarily guarantee admission. No candidate will be admitted unless the academic unit recommends admission. All applicants will be advised in writing by the Office of Graduate Studies of their admission status.

ADVANCED STANDING

With the consent of the academic unit, applicants may be granted Advanced Standing for up to one graduate level full course equivalent. No advanced credit from previous study will be given for undergraduate courses. Courses credited towards a previous degree or Qualifying Year can not be considered for Advanced Standing.

Requests for Advanced Standing must be submitted and approved at the time of admission to the program. To be considered for Advanced Standing, students must submit a formal request to the Office of Graduate Studies, along with the official transcript and institutionally prepared course description(s).

PROFICIENCY IN THE ENGLISH LANGUAGE

The language of instruction at Lakehead University is English. Students whose first language is not English must demonstrate that they can cope with the language demands of an English language university.

Applicants whose native language is not English, and who cannot verify having studied in an English language school system for more than three full years, will be required to present proof of English facility by:

1. Achieving appropriate standing on one of the following tests:

TEST	Minimum Score
TOEFL - Test of English as a Foreign Language	
TOEFL paper based	550 (with no component score less than 50)
TOEFL computer based	213 (with no component score less than 17)
TOEFL internet based	80 (with no component score less than 19)
IELTS - International English Language Testing System	6.5 (no individual band score less than 6.0)
MELAB - Michigan English Language Assessment Battery	85
CAEL - Canadian Academic English Language Assessment	60
Or	
2. Successfully completing the English for Academic Purposes (EAP) program offered jointly by Confederation College and Lakehead University. For more information, see Admission Requirements, V Requirements for Admission to Graduate Degree Programs.	
Certain academic units may require higher scores. Meeting the minimum requirements does not guarantee admission to Lakehead University.	
Where the language of instruction and examination in undergraduate studies has been uniformly in English, official documentation from the institution indicating that the primary medium of instruction is English must be submitted upon request. This official documentation must come directly from the institution in the form of an official letter that states that the student's medium of instruction was English for 3 years or more. This letter must be signed by the institution's Registrar or Chief Officer. This letter must also bear the original stamp or seal of the institution or a Notary Public.	
Lakehead University's Institution Code for TOEFL scores is 0888.	

READMISSION TO A GRADUATE PROGRAM

Students applying to enter a graduate program, who have previously withdrawn from the same or similar graduate program, must apply for re-admission to the program and pay the application fee. Students will be credited with previous courses completed and work undertaken towards completion of program requirements at the discretion of the academic unit. The academic unit may decline to allow previously completed courses to be accredited towards the graduate program applied for and/or may require a previous thesis topic to be changed in whole or in part.

The academic regulations and program requirements in effect at the time of re-admission shall apply. The allowable time-to-completion will include all previous terms in the program. Students who have reached their time limit in the program at the point of re-admission must complete the program within three consecutive terms.

REGISTRATION STATUS

Full-Time Graduate Student

A full-time graduate student must:

1. be designated by the University as a full-time graduate student;
2. be pursuing his or her studies full-time; and
3. normally, be geographically available and visit the campus regularly.

Without forfeiting full-time status, a graduate student, while still under supervision, may be absent from the university (e.g. visiting libraries, doing field work, attending a graduate course at another institution) provided that, if any such period of absence exceeds four weeks in any one term, written evidence shall be available in the Faculty of Graduate Studies to the effect that the absence has the approval of the supervisor and the Graduate Co-ordinator/Chair of the academic unit.

In accordance with the Ontario Council on Graduate Studies policy, the University recommends that a full-time graduate student will normally not be employed for more than an average of ten hours per week for any term. When the student is employed as a Graduate Assistant, the ten hours per week should represent the total time spent by the student in connection with this appointment. Requests for exceptions to this rule must be approved by the Dean of Graduate Studies.

Part-Time Graduate Student

All active graduate students, other than full-time graduate students as defined above, are part-time graduate students. **Graduate students registered part-time may not take more than one FCE during an academic year.**

REGISTRATION AND SELECTION OF COURSES

A student is not permitted to register as a graduate student until the application for admission has been approved. A graduate student proceeding to a degree is governed by the academic regulations and program requirements in the term of admission.

Before registering, students proceeding to a graduate degree must arrange their program with the assistance of the Graduate Co-ordinator of the program. Graduate students must complete all registration and withdrawal from courses by the published deadlines in the Academic Schedule of Dates. Late registration fees will apply after these dates. Any change in registration after the published deadlines must be formally requested on a "Request for Change in Registration" form.

The calendar year is divided into three terms: Fall Term (September-December); Winter Term (January-April) and Spring/Summer Term (May-August). Graduate students registering for the first time normally commence their program in the Fall Term. However, in some academic units students are permitted to commence their studies in January or May.

Registration is not complete until tuition and activity fees have been paid (or arrangements have been made to pay all fees) by the deadlines published in the University Fees, Fees Payment Information section of this Calendar. Default in fee payment may result in a student being de-registered. A student with amounts owing to the University will not be permitted to register in future sessions nor to receive a transcript or record of academic progress.

CONTINUANCE OF REGISTRATION

All graduate students must maintain continuous registration from initial registration until they have completed the requirements of their program. It is the student's responsibility to ensure they are registered by the appropriate deadline for each term. Students who have failed to register by the deadline and have not applied for a Leave of Absence will be registered in a University placeholder course and will be assessed appropriate fees.

Students who have failed to register for two consecutive terms will be considered to have left the program and will be withdrawn. Students wanting to complete their program must apply for re-admission and pay the application fee.

PERIOD OF STUDY

Masters Programs

Students in a Master's program are expected to complete all requirements within six terms (2 years) of continuous full-time registration.

An exception to this Period of Study is the Flexible (Flex) Full-Time option, available to students in the *Master of Education* and *Master of Public Health programs*. Students in this option are expected to complete all requirements within twelve consecutive terms (four years) as follows:

Six terms of continuous full-time registration

Followed by up to six additional terms of continuous registration, during which no fees are required.

As the Flexible Full-time option is intended for working professionals, students admitted will not be considered for financial support from the University.

Under exceptional circumstances, a student may be allowed to complete a Master's program on a part-time basis with the following conditions:

A student is admitted to the program part-time with the approval of the Office of Graduate Studies, based on special circumstances, provided at the time of application.

A part-time student may take no more than one full course equivalent per calendar year (12 months)

Part-time students are expected to complete all requirements within a minimum of fifteen terms (5 years) of continuous part-time registration.

- Part-time students will not be considered for financial support from the University.

For co-op students, the duration of the co-op placement will be added to the above time limits.

LEAVE OF ABSENCE

A **Leave of Absence** from a graduate program will be granted for exceptional circumstances only which will include: a limited term of external employment closely related to the program of study; health problems; parenting; compassionate grounds or other compelling circumstances. Leaves of Absence will be considered up to a three term limit.

A **Maternity/Parental Leave of Absence** from a graduate program will be granted to students that are either biological or adoptive parents, while they are caring for a new-born or newly adoptive child of any age. Maternity/Parental Leaves of Absence will be considered up to a three term limit per pregnancy or adoption and are in addition to any other Leave of Absence terms granted.

All Leave of Absence requests will be considered on an individual basis on the recommendation of the academic unit by the Faculty of Graduate Studies Council. A "stop-the-clock" policy will prevail with respect to payment of tuition fees and Period of Study. A graduate student granted a Leave of Absence will not have access to University faculty, library, laboratory or other facilities.

TIME EXTENSION

A **Time Extension** in a graduate program will be granted for exceptional circumstances on a per term basis up to a three term limit.

First Term Time Extension

Recommendations for the first term beyond the allowed Period of Study originates with the Supervisor for approval by the academic unit. It is the responsibility of the academic unit to send notice, including reasons for this approval, to the Office of Graduate Studies.

Second Term and Final Term Time Extensions

Recommendations for the second term and for the final term beyond the allowed Period of Study will be forwarded by the academic unit to the Faculty of Graduate Studies Council for consideration and final approval.

A graduate student who does not complete all requirements within one of the prescribed Periods of Study and does not receive an approved Time Extension is considered to have failed the program, unless the student applies for and is granted re-admission to the program.

A graduate student who does not successfully complete a graduate degree within the prescribed Period of Study must apply for re-admission to the program and pay the application fee. The academic regulations and program requirements in effect at the time of re-entry to the academic program shall apply.

WAIVER OF FEES DURING AN APPROVED TIME EXTENSION

Waiver of fees during the period of an approved Time Extension will be granted for exceptional circumstances only, which will include such issues as unavailability of supervision, required courses or resources. Cases will be considered on an individual basis by the Faculty of Graduate Studies Council, normally on the recommendation of the academic unit in which the student is enrolled. At the time of request for a waiver, the Graduate Co-ordinator must present a plan to the Council outlining how and when the issues will be resolved.

PROGRAM OF STUDY

The requirements of each graduate program are described in sections of the Calendar under the heading for the academic unit. Each student in a graduate program shall comply with any additional requirements of the academic unit in which the student is registered.

The course requirements for the degree will normally be at the fifth-year level. With the approval of the academic unit, a maximum of one full course equivalent at the fourth-year level may be accepted towards the Master's degree, provided the course has not been taken previously. Individual programs of study must be approved by the appropriate academic unit.

When a thesis is required, it will be on a subject approved by the appropriate academic unit upon the recommendation of the Supervisor following consultation with the student.

Each graduate student undertaking a thesis shall have the guidance of a Thesis Committee. The Committee is chaired by the Supervisor and consists of at least one other member of the academic unit. In addition, faculty from cognate academic units and other qualified persons from inside or outside the University may be appointed. An adjunct professor may be a Thesis Supervisor or a member of a thesis committee.

It is the responsibility of the Thesis Supervisor to ensure that a thesis involving human subjects and non-human vertebrates are approved, respectively, by the Senate Research Ethics Board, and the University Animal Care Committee, **before** a student's research begins. A copy of the approval notice must be forwarded to the Office of Graduate Studies for inclusion in the student's file.

Any change to a student's program (e.g. from thesis to course degree, field of specialization, supervisor) must be formally requested on the "Graduate Request for Program Change" form and approved by the Graduate Coordinator and the Office of Graduate Studies before being submitted to the Office of the Registrar.

GRADING SYSTEM

Course standings in the graduate programs will be reported as follows:

A+	90	to	100%
A	80	to	89%
B	70	to	79%
C	60	to	69%
Fail	1	to	59%
F	Academic Dishonesty		0
INC	Incomplete		

(see University Regulations, V Standing)

(For the exception regarding a failing grade, see Graduate Programs in the Faculty of Engineering, Academic Regulations.)

To maintain registration as a graduate student, a student must achieve and maintain satisfactory academic standing at all times. A student whose academic performance does not meet the minimum standing will be required to withdraw from the program.

MINIMUM SATISFACTORY ACADEMIC STANDING

Graduate students must maintain at least a B overall average in their courses with no more than one full course equivalent graded C. A mark of less than 60% in a graduate course, or in an undergraduate course used towards a graduate degree, constitutes failure. A graduate student with "a passing mark" or "a mark of 50 to 59%" in an undergraduate or graduate course may repeat the course. No more than one full course equivalent may be repeated. If after exercising this avenue for improving course marks, a student is still unable to achieve the minimum B overall average, the graduate student will not be permitted to continue in the program. (For exceptions to the regulations in this paragraph, see Graduate Programs in the Faculty of Engineering, Academic Regulations.)

Course marks below 50% are unacceptable in a graduate program. A graduate student with such a mark (half or full course) will not be permitted to continue in the program. Courses with a mark below 50% may not be repeated.

EXAMINATIONS

Graduate students enrolled in courses for credit must take all examinations in those courses.
A candidate may be required to take an oral examination during the Master's program.

COMPREHENSIVE EXAMINATIONS

Comprehensive examinations testing the student's knowledge in specified areas are required by some academic units.

SPECIAL EXAMINATIONS

Special examinations are not permitted for students registered in a graduate program.

THESIS EXAMINATION

The Master's thesis will be evaluated by at least two examiners, one of whom must be external to the academic unit/program. Upon receipt of each Examiner's Report a copy must be submitted to the Office of Graduate Studies.

Internal Examiners are appointed following a procedure established by the academic unit/program. An oral defense of the thesis may be required as part of the internal examination.

The **External Examiner** is recommended by the student's Thesis Committee and approved by the academic unit. Following the approval of the External Examiner, a completed thesis is submitted by the Supervisor to the Graduate Coordinator. All correspondence with the External Examiner is conducted by the academic unit.

In evaluating the thesis, the Examiners will make one of the following assessments:

1. Thesis Accepted
2. Accepted Subject to Revisions
3. Appreciable Revisions Required
4. Thesis Rejected.

A thesis evaluated as 'Appreciable Revisions Required' must be revised and returned to the Examiner for re-evaluation, through the Graduate Coordinator of the academic unit. Upon receipt, a copy of the assessment of the revised thesis must be submitted to the Office of Graduate Studies. If recommended by the Thesis Committee, a candidate receiving an evaluation of 'Thesis Rejected' will be allowed to resubmit the thesis to the Thesis Committee.

The final decision on accepting a thesis is made by the Thesis Committee after considering the reports of the Examiners. The student has failed the program if the thesis is rejected by the Thesis Committee following re-examination.

THESIS SUBMISSION PRIOR TO GRADUATION

The final thesis must be produced in a format acceptable to the academic unit which may include an electronic format that meets OCUL (Ontario Council of University Librarians) standards (see also requirements in the Department of Geology graduate program). A hard copy thesis must be legible and typed or printed on good quality bond paper, not less than 20 lb. weight. Laser-quality printing or equivalent is acceptable.

Three unbound copies of the final approved thesis are to be submitted to the Office of Graduate Studies. At least one copy must contain a frontispiece signed by the

Supervisor. The signature will signify that all comments made by Examiners have been considered by the author of the thesis and specified corrections have been made. Along with the thesis, the "License to the University" and the National Library of Canada forms must be signed by the student and submitted.

The graduate student will arrange payment for binding all three copies of the thesis. One copy of the thesis will be forwarded to the Library, one to the Supervisor, and one to the student. Each student must complete an Application to Graduate form and submit it to the Office of the Registrar by the **deadline dates** published in the Academic Schedule.

FEES FOR GRADUATE STUDENTS

For information regarding payment of fees, deadlines, methods of payment, refund schedule, miscellaneous fees, schedule of fees, co-op fees, and residence fees, see the Fees section of this Calendar.

Appendix G: Campus Map for the Locations of Offices and Labs

The offices of faculty members and labs are located in the CB building. The offices of graduate students are located in the CB building and RL building.