AERC POLICY MANUAL

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Preamble

The Policy Manual sets out rules and procedures for assessing Academic and Experience requirements for candidates wishing to be licensed or registered as an Ontario Land Surveyor (O.L.S.).

It is a guide for candidates, AOLS staff and members of the Academic and Experience Requirements Committee (AERC) to follow.

Licensing and Registration Designations

The following are licencing and registration designations offered by AOLS

1. O.L.S. – this designation is issued to candidates who have fulfilled all the requirements to be a licensed Ontario Land Surveyor authorized to perform cadastral surveying under the *Surveyors Act*. It also applies to candidates who have fulfilled all the requirements to be a registered Ontario Land Surveyor authorized to perform professional surveying under the *Surveyors Act*.
2. O.L.S. (LL) – this designation is issued to candidates who have fulfilled all the requirements to be a limited licensed Ontario Land Surveyor authorized to perform cadastral surveying under the *Surveyors Act*. Candidates holding this designation have limitations on the type of work they are allowed to perform.
3. O.L.S. (T) – this designation is issued to candidates who are already licensed in another jurisdiction and are issued a temporary license by the Registrar in emergency situations to perform cadastral and professional surveying work in Ontario. The AERC does not approve this license type.

Licensing Process

In general, candidates must meet all three of the above noted requirements to be licensed. Candidates applying through the “Agreement of Internal Trade” (A.I.T.) route, must successfully write a professional exam.

Parallel processes

AOLS allows parallel processes in which a candidate who is completing one of the requirements can start completing another requirement.

A candidate can begin completing their "experience" requirement while completing their academic requirements if they do not need to obtain academic credit for more than three academic courses.

A candidate can complete the "exam" requirement by taking the statutes exam while they are completing their experience requirement.

Academic Requirements

All candidates (except those applying through the AIT route) applying for a licence, limited licence or certificate of registration must meet AOLS academic requirements as noted in Appendix A.

To meet the academic requirements, all candidates must apply for an academic assessment.

Every 5 years, AERC will review the academic requirements to ensure they are current and relevant. Appendix A will be updated and re-appended as required during the cycle review.

Application Process

Candidates applying for an academic assessment must provide a complete application to the Office of the Registrar. A complete application includes the following:

1. The Academic Assessment Fee (see Appendix B – Fee Schedule)
2. All official post secondary transcripts
3. Application form
4. Detailed Resume
5. Detailed Course Descriptions

Incomplete applications will not be considered or processed.

Official Transcripts

All transcripts provided by the candidate must be original or certified true copies stamped by the issuing academic institution.

Alternate Documents Policy

Candidates may request an exception to providing Official Transcripts if they cannot obtain their original or certified true copy of their transcript for the following reasons:

- The area in which the academic institution resides is under war or civil unrest
- The academic institution was destroyed because of war or terrorism
- The academic institution has a policy not to share records with foreign countries.

Requests for exceptions will be evaluated on a case-by-case basis and may be denied by the Registrar. Additional reasons for alternate documents may be considered by the AERC.

International Education

Where an applicant has been educated internationally, they are first required to apply to either the Comparative Education Service (CES) of the University of Toronto or the World Education Services (WES) and request a "document by document" evaluation from one of those services for submission to the AOLS.

Assessment Process

All complete applications will be assessed in accordance with the AERC Evaluation Process as in Appendix F

Qualifications for Academic Evaluators

The minimum qualification requirements for an Academic Evaluator are as follows:

- Active or Inactive University Professors;
- Knowledgeable of the academic requirements of all branches of Professional Land Surveying listed under the Surveyors Act;
- Knowledgeable in the field of Geomatics and Land Surveying

CBEPS

Candidates may apply directly to the Canadian Board of Examiners for Professional Surveyors (CBEPS) for an academic assessment. Candidates who receive a Certificate of Completion from CBEPS, will be deemed to have met the AOLS academic requirements.

A member of AERC is included in the CBEPS Board to keep informed of any changes to their assessment processes. Any time a change to the CBEPS requirements occurs, AERC will review the new requirements and determine if they are aligned with AOLS requirements. See Appendix G for currently accepted requirements.

Experience Requirements

Candidates who have successfully meet the academic requirements may begin to be assessed to determine if they meet the experience requirements. As noted above, candidates may apply to have their experience assessed if they have no more than three required academic credits to obtain.

Core Competencies

To successfully meet the AOLS experience requirements, all candidates must demonstrate they meet the required Core Competencies related to the type of licence they are applying for as noted in Appendix C.

To demonstrate that a candidate meets the Core Competencies, a candidate can apply for one of the following:

1. A Competency Based Assessment (CBA)
2. Articles

Competency Based Assessment (CBA)

Candidates must meet the statutory experience requirement (below) before applying for a Competency Based Assessment. Candidates choosing this option must provide a complete application to be considered. Incomplete applications will not be processed. A complete application includes the following:

1. Payment of the CBA Assessment Fee
2. Completed Work Experience Form with all necessary fields filled out.
3. Samples of their work which demonstrate each enabling competency.

Verification of Validators

The CBA form contains a section for each of the relevant Core Competencies. In each Section, the candidate must list a validator who can validate the experience listed. Validators must be authorized to practice professional land surveying in their home country.

All Validators must be confirmed as authorized to practice professional land surveying in their home country by AOLS staff. Validators may be interviewed by the Assessor (member of AERC) to determine if they have sufficient knowledge to have validated the candidate's experience. If a Validator does not have sufficient knowledge of the candidate's experience or sufficient knowledge of the Core Competency, the Validator will not be approved and the experience listed in that section will not count towards the candidate's experience.

Minimum Statutory Term Requirements

Candidates must demonstrate that their experience meets the minimum statutory term requirements. These include:

1. 150 working days at a Party Chief Level
2. 75 working days at a Non-Party Chief Level
3. 113 working days of Management and Administration

For clarity:

Party Chief Level means leading a field crew and making decisions in the field on how to set up a project, what evidence to collect, preparing field notes, performing complex calculations, overseeing the other members in the field crew, reporting to the project manager or supervising surveyor, ensuring the equipment is calibrated and in peak operational condition, liaising with the client or client representative on site, liaising with other site professionals and trades.

Non-Party Chief Level means participating on a field crew, setting up field equipment, looking for evidence, supporting the party chief.

Management and Administration means project management, preparing quotes, preparing correspondence, planning projects, registry office searching, reviewing reports and plans of survey, preparation of reports and invoices, and delivering of final returns.

Applications that do not demonstrate they meet the minimum statutory term requirements will be rejected.

Reduction of Minimum Statutory Terms Requirements

Candidates who apply under the CBA will not be eligible to apply for a reduction of the minimum statutory term requirement. This is because candidates should include all relevant time in their application.

Assessment Process

Each application will be assessed by two members of the AERC who will report their scores to the AERC for final decision. The Office of the Registrar will report scores to the candidates. Candidates must achieve a rating of 3 in each of the Core Competencies to meet the experience requirements. Candidates who do not achieve a score of 3 in a particular competency will need to re-apply once they have achieved additional experience in that competency.

Candidates may achieve that additional experience through the following options:

1. Obtain additional experience for that competency by articling to an Ontario Land Surveyor
2. Obtain additional experience for that competency by completing relevant work in a place that offers that opportunity.

For candidates who achieve a rating of 2 in a particular competency, the AERC assessors may recommend completing an assignment developed by AOLS in that competency to meet the requirement, if available. This will be determined on a case-by-case basis. Assignments must be submitted to the Office of the Registrar to be marked. Assignments will be assessed by the AERC members and/ or Assistants to the AERC with the support of Subject Matter Experts as needed. Successful completion of an assignment will result in achieving the requirements of that particular competency.

Candidates who do not achieve a minimum rating of 3 in a particular competency and who choose to article, must complete the articling process described in this section.

When assessing an application, only the score needs to be provided back to the applicant. Rationale for the score is listed in the CBA Application Guide.

CBA Appeal Process

If a candidate does not agree with the assessment made by AERC, they can apply for an appeal. Appeals will be reviewed by two alternate members of AERC and their decision will be final. Only complete appeal applications will be considered.

A complete appeal application includes:

1. The appeal application fee.
2. A completed appeal application.
3. A cover letter indicating the grounds upon which the Appeal is being made.

Articling Process

Candidates who wish to article to meet the experience requirements to be an Ontario Licensed or Ontario Limited Licenced surveyor must do so under a fully licenced member in good standing who has been licensed for a minimum of 3 years. See Appendix H

Candidates who wish to article to meet the experience requirements to be an Ontario Registered surveyor must do so under a fully licenced or registered member in good standing who has been licenced or registered for a minimum of 3 years.

All candidates who wish to article must submit a complete application to be considered.

A complete application includes the following:

1. The articling application fee.
2. A completed articling contract signed by the candidate and the articling surveyor.
3. A letter of good character.

The completed application will be reviewed by the Registrar who will also confirm that the Articling Surveyor meets the AERC requirements for this role. Candidates will be informed by the Registrar if their articling application has been approved. AERC will assign a member of AERC or an Assistant to AERC to act as a monitor.

Rejection of Articling Applications

Should the Registrar reject an articling application, the candidate may appeal the decision to the AERC.

Minimum Statutory Term Requirements.

During the articling period, candidates must achieve the minimum statutory term requirements. These include:

1. 150 working days at a Party Chief Level
2. 75 working days at a Non-Party Chief Level
3. 113 working days of Management and Administration

For clarity:

Party Chief Level means leading a field crew and making decisions in the field on how to set up a project, what evidence to collect, preparing field notes, performing complex calculations, overseeing the other members in the field crew, reporting to the project manager or supervising surveyor, ensuring the equipment is calibrated and in peak operational condition, liaising with the client or client representative on site, liaising with other site professionals and trades.

Non-Party Chief Level means participating on a field crew, setting up field equipment, looking for evidence, supporting the party chief.

Management and Administration means project management, preparing quotes, preparing correspondence, planning projects, registry office searching, reviewing reports and plans of survey, preparation of reports and invoices, and delivering of final returns.

Candidates who do not achieve the minimum statutory term requirements will be deemed to have not completed their articling.

Reduction of Articles

A Reduction in the term of Articles will not be considered for experience gained prior to substantial completion of a candidate's academic requirements. The candidate must have been within 3 courses of completing their educational requirement before experience can be considered for a reduction. See the Application for Reduction in Articling Time Student Guide for more information. Candidates must submit a complete application to apply for a reduction to the minimum statutory terms. A complete application includes:

1. The reduction application fee.
2. Cover Letter outlining documents submitted and how they pertain to the applicant's experience
3. Completed Candidate Assessment Form
4. Completed "Summary of Information for Application for Reduction in Term of Articles" form (Appendix E from the Student Articling Handbook).
5. Detailed Resume outlining previous employment experience
6. Detailed information regarding discipline specific experience upon which the request is being made. This may include letters from current and previous employers and samples of field notes, plans and reports prepared by the candidate or in which the candidate played a significant role

Applications will be considered by the AERC at the next available meeting. Decisions of the AERC for reduction of articles are final.

Articling Period

All candidates must complete their term of articles within 4 years.

Extension to the Articling Period

Candidates who do not expect to complete their articles within the 4 year term, and wish to extend their term, must apply for an extension no later than 30 days prior to their articles expiring. The candidate must apply in writing and must detail why they require an extension and the length of the extension. An extension considered by AERC for extenuating circumstances in accordance with current legislation and by-laws.

Certificate of Completion

Upon successfully meeting all the Core Competency requirements, candidates must obtain a Certificate of Completion (see Appendix D) from their articling surveyor and submit it to the Registrar. In the case where a candidate has articled under more than one articling

surveyor, the most recent articling surveyor will complete the form and will take responsibility for determining that the candidate is competent in all requirements.

Upon receiving and accepting the Certificate of Completion, the Registrar will inform the candidate that they are eligible to challenge the next available set of Professional Exams.

Transfer of Articles

Candidates may transfer articles from one surveyor to another. Upon transferring articles, candidates must inform the Registrar in writing and submit the following:

1. Articling transfer fee
2. Transfer of Articles Form (see Appendix E) to the Registrar
3. Articling contract (see Appendix F)

Cancellation of Articles

A candidate's articling contract may be cancelled by the Registrar for the following reasons:

1. They did not complete their articles within the 4-year term and did not apply for or were not granted an extension.
2. They were found not to be of good character.
3. 3 exam failures (see below)
4. the candidate requests a cancellation

Candidates who do not complete their articles within the 4-year period, will be cancelled unless an application for extension is received and any progress they have made will be archived in the AOLS database and kept for a maximum of 4 years. After that all information relating to the candidate will be deleted from the database.

Candidates who are cancelled and wish to reapply may do so by submitting a new application and paying the applicable fees. A new educational assessment will be required is the previous assessment has expired (See Appendix I). They may also submit a reduction of articles application if they reapply within 4 years of their articles being cancelled. There is no limit to how many times a candidate may reapply to article.

Candidates who were cancelled due to character concerns, must abide by the terms stipulated to them by the Registrar.

All notices of cancellation will be sent to the candidate in writing by electronic or regular mail.

AERC does not approve or review cancellations.

Exams

The AOLS administers five types of exams:

1. The Statutes Exam
2. The Professional Written Exam
3. The Professional Oral Exam
4. The Plan Check Exam
5. Agreement on Internal Trade (A.I.T.) Exam

Eligibility to Challenge Exams

To challenge the Professional Written, Professional Oral and Plan Check Exams, students must have completed their Academic and Experience Requirements and must be approved by the Registrar. Completing the experience requirements means, that their CBA application has been approved, or they have received a Certificate of Completion from their articling surveyor. A candidate must have also completed the professional lecture course prior to exam registration.

To challenge the A.I.T. exam, a candidate must hold a valid licence issued by Canadian Land Surveying Association and must be in good standing with the licensing body.

Prior to writing any exam, candidates must pay the applicable exam fee.

Pass Rate

A candidate must achieve a 65% or better on any exam to be considered having passed the exam.

Number of Attempts

Should a candidate fail any of the Statues, Professional Written, Professional Oral or Plan Check exam after three (3) attempts, the candidate will not be able to challenge the exam until one year has passed since they last failed the exam. The candidate will receive a maximum of three (3) additional attempts to challenge the exam. Should the candidate fail to pass the exam after these three (3) additional attempts, the candidate will not be able to challenge the exam at any time and will not be eligible for licensure.

Confidentiality

All candidates who write any of the exams, must not share the exam contents with anyone. Any candidates who are caught sharing exam contents with others will be subject to a character concern.

Proctoring

All exams will be proctored to ensure all candidates have equal opportunity to challenge the exam. Anyone caught cheating on an exam will be disqualified from the exam. The Registrar may impose conditions on the candidate in terms of their eligibility to write future exams. Each instance of a candidate caught cheating will be examined on a case-by-case basis.

Marking Scheme

Each question in the Statutes Exam will be marked as either correct or incorrect and the cumulative total of correct marks must meet the pass rate prescribed by bylaw.

Each question in the Professional Written Exam will be marked by two independent markers on the AERC committee. Should the two marks provided by the markers be within a 25% differential, the average of the two marks will be used as the candidate's final mark for that question. Should the two marks provided by the markers be in excess of a 25% differential, the question will be remarked by two other markers, one of which is a member of the AERC, and the new average mark will serve as the final mark for that question. The final mark for each question will be presented to the Registrar who will then calculate the final mark for the exam for each candidate. The candidate's cumulative final mark for each question must meet the pass rate prescribed above.

The oral exam will be administered by a panel of three AERC members or assistants to AERC . One member of the panel will be the panel chair who must be an active member on the AERC and not an assistant. Each instance of an oral exam will be immediately marked once the oral exam is complete and the candidate is not present. The team lead will record the final mark and present it to the Registrar. The candidate must meet the pass rate prescribed above. In the event of a failure, a failure report will be prepared by the panel chair and circulated to the other panel members by email for comment and finalization. Once finalised, the failure report will be forwarded to the Registrar.

The Plan Check exam will be marked by two independent members of the AERC. A mark will be provided for every correct error a candidate finds and a mark will be taken off for an incorrect error identified by the candidate. The candidate must meet the pass rate prescribed by bylaw.

Each question in the A.I.T. exam will be marked by two independent markers of AERC or assistants to AERC. Should the two marks provided by the markers be within a 25% differential, the average of the two marks will be used as the candidate's final mark for that question. Should the two marks provided by the markers be in excess of a 25% differential, the question will be remarked by two other markers, one of which is a member of the AERC,

and the new average mark will serve as the final mark for that question. The final mark for each question will be presented to the Registrar who will then calculate the final mark for the exam for each candidate. The candidate's cumulative final mark for each question must meet the pass rate prescribed above.

Communication of Results to Candidates

Results of the exam will be communicated in writing to the candidates by the Office of the Registrar within 45 working days of the exam date. The return will include the following:

1. Statutes Exam –pass or fail with % grade.
2. Professional Written Exam – mark for each question, competency covered by the question and overall pass or fail with % grade.
3. Professional Oral Exam – name of each member on the exam panel and pass or fail determination (no % grade).
4. Plan Check Exam – pass or fail with % grade.

Under no circumstance will the exam or the candidate's responses to the exams be provided back to the candidate.

Individual exam results do not need to be approved by AERC. However, AERC will review the exam grades for insight into validity of the exams, identifying issues with exam questions, etc.

Appeal of Exams

Candidates may appeal their exams if they feel the process wasn't followed or that one or more of the markers had an apparent conflict of interest and did not declare it. An application for an appeal must be accompanied by a cover letter stating the reason for the appeal.

Application for Licensure

Candidates must be eligible to apply for a license or certificate of registration. An eligible candidate must have met the following criteria:

1. They must have successfully completed the AOLS academic requirements.
2. They must have successfully completed the AOLS experience requirements.

They must have successfully challenged the AOLS exams.

For A.I.T. candidates only, they must have had their application approved and they must have successfully challenged the A.I.T. exam.

All candidates who apply for a licence or certificate of registration must submit the application for professional status form (Appendix D) to the Registrar. Once the form has been accepted and approved, candidates will receive a notice of their swearing-in ceremony.

Appendix A

AOLS Academic Requirements

SUBJECT	DESCRIPTION
MATHEMATICS	Functions, continuity and limits; Differentiation and applications; Integration, quadrature's and applications; Plan curves, tangency, and curvature; Sequences, series and Taylors expansions; Partial differentiation and differential operators; Multiple integrals and numerical approximations; Vector operations and analytical geometry' First and second order linear differential equations and solutions; Introduction of matrix algebra, linear equations and transformations; Complex variables, linear spaces and subspaces; Quadratic forms, orthogonal and unitary matrices; Spherical geometry and trigonometry.
PHYSICS	Motion; Waves; Sound; Electric Charges and Fields, Magnetic Field and Forces, Electromagnetic Induction; Electromagnetic Waves, Propagation of Light, Optics and Optical Instruments, Interference and Diffraction.
COMPUTING	One computer course that focuses on computer programming, website development, custom programming scripting, or application development. A Ryerson or York computer course that is completed through an engineering degree is acceptable. Alternative, on-line or night school courses will also be accepted (with course content approval by AERC). Examples of online courses include Introduction to ASP.NET, Introduction to C++, Introduction to Programming, Introduction to JavaScript, Introduction to Visual Basic, Mac, iPhone, and iPad Programming (All U of Waterloo online courses)
FUNDAMENTALS OF SURVEYING	Acquisition of Data by Field Survey Methods, and Processing these Data to Determine Positions and Direction; Field Note Procedures; Preparation of Maps of Physical and Cultural Phenomena; Coordinate Geometry; Curve Geometry; Earth Work Calculations; Digital Models; Error.
LEAST SQUARES ESTIMATION AND DATA ANALYSIS	Pre-Analysis and Design of Surveys; Error Analysis of Resultant Data and Techniques; High Precision Surveys, including Deformation Surveys; Application of Matrix Methods and the Computer to the Analysis of Survey Problems; Linear Equations and Their Methods of Solution; Linearization of Computational Models; Coordinate Transformations. Survey Control Systems; Statistical Analysis of Survey Data including Estimation of Variance Components; Regression Analysis; Models; Filters; Adjustment of Large Survey Networks; Estimation of Reliability and Accuracy of Survey Systems.
PHOTOGRAMMETRY AND REMOTE SENSING	

	Analytical Principles and Procedures; Spatial Triangulation; Digital Photogrammetry; Soft Copy; Project Planning and Execution; Remotely Sensed Digital Images; Computer-Assisted Interpretation; Preprocessing and Pattern Recognition; Resource Mapping and Monitoring.
GIS/LAND MANAGEMENT AND LAND INFORMATION SYSTEMS	Spatial Data Management Systems; Alternative Methods of GeoReferencing; Spatial Data Representation; Creation and Revision of Digital Map Data; Data Integration and Geoprocessing; Hardware and Software Components of a GIS; Project Selection; Design and Implementation-, Review of Selected Geographic Information Systems in Canada.
GEODESY	Concepts and Evolution of Geodesy; Terrestrial and Satellite-Based Methods of Positioning; Introduction to Global Positioning Systems. Gravitational Potential; Gravity Field; Principles of Satellite and Inertial Positioning Systems; Levelling and Geopotential Numbers; Tidal Effects; Theory of Orbits; the Geoid.
PROFESSIONAL AFFAIRS & BUSINESS LAW	Role and Responsibilities of Professions from the Historical, Ethical, Legal, Organizational and Commercial Perspectives; Exploration of the Fundamentals of Professional Judgement; Conduct; Practice Creation and Management. Attendance of the OSPE Prepatory Course for the Professional Practice Exam would also suffice as an equivelent. Overview of the Role and purpose of the Canadian Legal System; The Canadian Constitution; The Structure and Operations of our Civil Courts; The Establishment of Law, including Statutes and Common Law; The Impact of Laws on Individuals and Business Entities.
LAND PLANNING	Fundamentals of obtaining Site Information to provide the Framework for Land Development; Subdivision Design; Economics of Development; Aggregate Resource Development; Condominium Legislation and Approval; Drainage Legislation and Engineering; Role and Involvement of the Professional Surveyor as a Member of the Multi-Disciplinary Planning Development Team; Effective Public Participation and Stakeholder Involvement; Strategies for Presentation.
EFFECTIVE COMMUNICATION	Principles, Styles and Techniques of Technical Writing; Narrative; Descriptive; Expository and Persuasive Prose; Correct Grammar; Sentence and Paragraph Structure; Clarity, Precision and Consistency; Writing Memoranda, Business Letters, Announcements, Abstracts, Reports, Instructional Manuals, Brochures and Specifications; Basic Communication within an Organizational Structure; Presentation of Technical Information for a Variety of Audiences.
SURVEY LAW I:	

REAL PROPERTY	Real Property; Land Parcels and Property Rights; Survey Systems; Crown Lands; Grants and Surveys
SURVEY LAW II: PARCELS RECORDS AND BOUNDARIES	Creation of Boundaries; Principles of Evidence; Estoppel; Adverse Possession; Natural Boundaries; Description of Lands.
HYDROGRAPHY	The learning outcomes of hydrography are divided into several sections including acoustics, bottom determination, water levels, water flow, horizontal positioning, vertical positioning and hydrographic survey practices and standards.

Appendix B

Core Competencies

These core competencies must be achieved for entrance into the profession, and maintained throughout licensure. They state outcomes and enabling competencies in terms of what a professional land surveyor will be able to do. They are not a checklist. A professional land surveyor must understand the importance of ethics and professionalism in applying, interpreting, and executing one's professional practice in order to be deserving of public trust and confidence. The core competencies set out in this document must be practiced by a professional land surveyor who is embracing ethics and professionalism as a personal quality infusing all areas of competency and practice. Ethics and professionalism are foundational to the Association and its practitioners being able to deserve and maintain public trust.

This s a summary of core competencies for a professional land surveyor. It is not intended to detail all competencies or infer that every competency is fully articulated. An example of this is the requirement for knowledge of an extensive list of Statutes and Regulations, not herein itemized. Another example of the limited scope of this document, is the notion that a professional land surveyor will be expected to follow all of the laws of Ontario and Canada, not just the laws that are set out in this statement of Core Competencies.

Core Competencies for License

Professionalism: Ethics

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Demonstrate an understanding that protection of the public interest is the overarching purpose for acting ethically in the exercise of their profession. B. Demonstrate a commitment to the public by applying best practices and adhering to ethical conduct. C. Demonstrate an understanding of the duty of the surveyor to provide impartial boundary opinions supported by the assessment of evidence and principles established by law. D. Demonstrate an understanding of professional self-regulation.	1. Fulfill and adhere to: a. The AOLS Code of Ethics b. The AOLS Standards of Practice c. The Statutes and Regulations governing the practice of surveying. 2. Undertake work within one's personal scope of professional practice (i.e. possess the knowledge, competence and resources relevant to the specific job). 3. Demonstrate an understanding of the professional scope and geographic jurisdiction that the AOLS licence permits (e.g. distinguish between provincial and Canada lands). 4. Identify and manage conflicts of interest. 5. Demonstrate and understanding of the obligations for communicating with, or responding to, the AOLS in a timely manner. 6. Demonstrate a commitment to participate in the self-regulating professional activities of the AOLS. 7. Demonstrate an understanding of rights and responsibilities outlined in the *Ontario Human Rights Code*.

Professionalism: Communication

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Communicate effectively, in written and verbal form. B. Clearly articulate the work processes and analysis for boundary retracement and other land surveying projects.	1. Write professional reports, submissions and letters. 2. Articulate the assessment of evidence and legal principles used to determine the location of a boundary. 3. Demonstrate an understanding of the documentation required to support the preparation of professional reports. 4. Demonstrate an understanding of timely, effective, and appropriate communication with clients, other

	surveyors, other professionals, prospective clients, the public, and government. 5. Demonstrate an understanding of effective communication skills for working with co-workers, staff, peers, and on teams. 6. Advise clients on appropriate surveying services for their situation. 7. Demonstrate an understanding of the Ontario legal system and the role of the surveyor as an expert witness.

Professionalism: Business Practices

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Demonstrate knowledge of the basics of business practices.	Demonstrate knowledge in: 1. Business Finance 2. Business and Professional Liability and Insurance 3. Project Management 4. Client Contracts 5. General Office Organization and Procedures 6. Business Law and Standards 7. Human Resources 8. Health and Safety

Cadastral Boundaries: Research

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Carry out the documentary and field research required to assess the evidence for boundary retracement. B. Report on the research and analysis of evidence undertaken for a boundary retracement.	1. Conduct research in the Ontario land registration system with an ability to understand and analyse these records. 2. Identify, obtain, interpret, and analyse historical survey records from surveyors and other sources. 3. Carry out research in the field, including: a. recognizing and assessing evidence of original monumentation, the first establishment of a boundary, and subsequent retracements, and

	b. obtaining oral and written evidence from owners and others. 4. Demonstrate knowledge of sources for documentary research including Ontario and Canada Lands survey records, and national, provincial, municipal, and other archives. 5. Demonstrate an understanding of the use of a formal affidavit to document evidence.

Cadastral Boundaries: General Boundary Retracement

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Demonstrate knowledge of, apply, and report on the methodologies, legal principles and case law required to complete boundary retracements.	1. Demonstrate an understanding of, and apply, the principles of boundary retracement, statute and case law, including but not limited to: a. hierarchy of evidence, b. priority of registration, c. appropriate use of proportioning, d. intention of the original parties to boundary creation, e. intrinsic and extrinsic evidence, f. possessory interests, and g. evidence of boundary creation. 2. Report on the analysis of evidence based on the principles of boundary retracement, statute and case law. 3. Demonstrate knowledge of the use and effect of different types of surveys, including written reports, plans, sketches, and digital information. 4. Demonstrate knowledge about the resolution of boundary problems and conflicting surveys including the surveyor's role in a. reporting on issues arising from boundary retracement, b. proceedings under The Boundaries Act, and c. Judicial determinations.

Cadastral Boundaries: Descriptions

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Interpret the various forms of legal descriptions in terms of what evidence can be used to complete boundary surveys. B. Report and advise on descriptions based on an understanding of statute and case law, and land registration records.	1. Demonstrate an understanding of the nature and role of descriptions in boundary retracement including but not limited to: a. types of legal descriptions, and b. interpretation of descriptions. 2. Apply principles of statute and case law regarding descriptions, including but not limited to: a. conventional lines, b. misdescriptions, and c. O. Reg. 43/96 Surveys, Plans and Descriptions of Land. 3. Prepare a description in accordance with statutes & regulations. 4. Demonstrate an understanding of latent and patent ambiguity in descriptions together with an ability to report and advise on potential solutions.

Cadastral Boundaries: Easements

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Demonstrate an understanding of easements. B. Report on easements based on an understanding of statute and case law, and land registration records.	1. Demonstrate knowledge of: a. what constitutes a validly created easement, b. prescriptive easements, c. easements in gross, and d. statute and case law related to easements. 2. Identify and report on registered and unregistered easement interests.

Cadastral Boundaries: Roads

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Demonstrate an understanding of roads, including	1. Demonstrate an understanding of statute and case law regarding roads including:

a. where roads originate, b. the extent of roads, c. the difference between road ownership and jurisdiction, and d. how road interests are transferred. B. Report on roads based on an understanding of statute and case law, and land registration records.	a. road dedication and acceptance, b. legislation and municipal bylaws, c. Original Township Road Allowances and Shore Road Allowances, d. road access issues, e. travelled roads, forced roads, and colonization roads, f. Quarter Session roads, and g. the Ministry of Transportation Ontario (MTO) Plan Types and their effect and the Highways Register (Land Titles Act Section 72(2)). 2. Retrace the boundaries of a road and report on any complexities of extent, jurisdiction, or registered ownership of the road.

Cadastral Boundaries: Water Boundaries

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Apply and report on the legal principles set out in the statute and case law in the process of arriving at an opinion on the location of a water boundary.	1. Survey and report on the methods used to locate water boundaries in accordance with legislation and best practice. 2. Demonstrate an understanding of the principles of water boundaries in statute and case law, including but not limited to: a. riparian interests and ambulatory water boundaries, b. flooded lands including methods of retracing the limit prior to flooding, and c. ad medium filum. 3. Demonstrate an understanding of accretion and erosion including recognizing the signs of accretion or erosion as opposed to flooding or reliction and determining distribution of accreted lands. 4. Demonstrate an understanding of federal and provincial legislation regarding rights of navigation and ownership of the bed of a water body.

	5. Demonstrate an understanding of case and statute law and the surveyor's role in the determination of navigability. 6. Demonstrate an understanding of the research for, and how to interpret, the intent of a subdivider of a plan of subdivision adjacent to a body of water.

Cadastral Boundaries: Original Township Retracement

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Demonstrate knowledge of the statutory methods of retracing original township surveys as set out in the *Surveys Act*.	1. Demonstrate knowledge of: a. Original Township Systems, b. Original Township boundary retracement and *Methods of Survey* as identified in the *Surveys Act* including the statutory methods of re-establishing lost lot corners, concession corners or township corners in original township surveys, and c. Setting an aliquot part boundary. 2. Demonstrate an understanding of the difference between the first running of a township, lot, or concession boundary and a retracement. 3. Research and interpret historical records related to the Original Township being surveyed including: a. instructions from the Crown, b. field notes, c. survey reports and diaries, d. the original Plan of Survey, annulments, re-surveys, and e. retracement surveys.

Cadastral Boundaries: Possessory Interests and Adverse Possession

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Differentiate adverse possession from possessory evidence used to re-establish boundaries. B. Report on possessory interests and/or adverse possession including a description of issues and potential solutions.	1. Demonstrate an understanding of the principles of statute and case law regarding possessory interests as evidence for boundary retracement and the principles of statute and case law for adverse possession. 2. Distinguish the surveyor's scope of expertise from that of lawyers with regard to adverse possession. *3.* Describe when a parcel of land may be subject to claims of adverse possession under the *Land Titles Act*. 4. Describe the process of perfecting a claim of adverse possession under the *Land Titles Act*.

Spatial Reference

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Demonstrate knowledge of the requirements and best practices for measuring, georeferencing, datums, and projections. B. Document and report on spatial reference observations.	1. Demonstrate an understanding of Geodetic Coordinate Systems and Vertical Datums used in Ontario. 2. Demonstrate an understanding of the concepts of Ellipsoidal Heights, Orthometric Heights, Geoid Models, and their relationships. 3. Demonstrate an understanding of the benefits and limitations of different measuring techniques/equipment used to determine three dimensional coordinates. 4. Demonstrate an understanding of coordinate transformation from one Geodetic Coordinate System to another and the limitations of the transformation processes.

	5. Demonstrate an understanding of the integration requirements for registered and deposited plans as required by Ontario regulation. 6. Demonstrate an understanding of survey observations, error propagation, analysis, adjustment, accuracy, and blunders.

Land and Resource Development

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Demonstrate knowledge of the roles and responsibilities of the surveyor in the development of land and resources under Ontario law. B. Maintain up-to-date knowledge of land and resource development laws. C. Work on interdisciplinary project teams demonstrating an understanding of the roles of other professionals, the owner, and developer.	1. Demonstrate knowledge of condominiums under the *Condominium Act* including: a. the types of condominiums and the process of obtaining approval and registration for each type, b. the role of the surveyor in preparing plans and descriptions for a condominium, and c. the role of the surveyor in working with other professionals and the developer in the development of a condominium. 2. Demonstrate knowledge of the division of land and interests in land under the *Planning Act* including: a. the role of land use planning, the intent of the *Planning Act* and other policy statements, plans, and zoning by-laws, b. the surveyor's role in the application and approval of a Plan of Subdivision, c. the processes for registration of a Plan of Subdivision, d. the process of application and approval for the division of land under Consent, e. the use of a Reference plan for the description of easements and land division, and f. the use of a Strata Plan to describe three dimensional interests. 3. Demonstrate a general understanding of the *Mining Act*.

Statutes and Regulations

Outcome: A surveyor will be able to:	Enabling Competencies: A surveyor will be able to:
A. Apply all relevant statutes and regulations to the practice of land surveying.	1. Demonstrate an understanding of all provincial and federal statutes and regulations relevant to the practice of professional land surveying including statutes and regulations set out by the AOLS in five categories: a. Primary – those that directly set surveying requirements b. Secondary – those that impact surveying requirements c. Teritary – those that have peripheral impact on surveying d. Federal – Statutes from Canada e. Repealed Statutes – statutes that no longer exist but would have impacted historical surveying decisions

Core Competencies for Limited Licence

The Core Competencies for Limited Licence are as follows:

1. Professionalism: Ethics
2. Professionalism: Communication
3. Professionalism: Business Practices
4. Cadastral Boundaries: Research
5. Cadastral Boundaries: General Boundary Retracement
6. Cadastral Boundaries: Easements
7. Spatial Reference
8. Statutes and Regulations.

Details for each of the core competencies can be found in this document.

Core Competencies for Geodetic Surveying

To be developed

Core Competencies for Hydrographic Surveying

To be developed

Core Competencies for Photogrammetric Surveying

To be developed

Core Competencies for Geographic Information Management

To be developed

Appendix C

Certificate of Completion

Name of Articling Surveyor (herein after referred to as the “Articling Surveyor”)

_____

Name of Articling Student (herein after referred to as the “Student”)

_____

I, articling surveyor certify that student has achieved sufficient knowledge and experience in each of the enabling competencies to achieve the outcomes in the relevant competencies that were identified in the articling contract executed between the articling surveyor and the student on _____.

I certify that the student has achieved the minimum statutory term requirements namely being:

1. 150 working days at a Party Chief Level
2. 75 working days at a Non-Party Chief Level
3. 113 working days of Management and Administration

I further certify that the knowledge and experience achieved by the student was under my personal supervision and that I recommend to the Registrar that the student is ready to proceed to the next step in the licensing process, which is to challenge the professional exams.

I am aware that making a providing a false Certificate of Completion will constitute professional misconduct and that in doing so, I may be subject to disciplinary action.

Dated at _____ the _____day of _____, 20____

_____

Signature and Seal of Articling Surveyor

Appendix D

Transfer of Articles

Name of Student (“Articling Student”):

Name of surveyor from which the articles are being transferred from (“Articling Surveyor 1”):

Name of surveyor to which the articles are being transferred to (“Articling Surveyor 2”):

I, Articling Student, wish to transfer my articles from Articling Surveyor 1 to Articling Surveyor 2. I understand that in doing so, that Articling Surveyor 2 must be satisfied that I have sufficient knowledge and experience in each of the relevant core competencies before providing a certificate of Completion.

I further understand that some or all of the minimum statutory term requirements obtained while with Articling Surveyor 1 may not fully be transferrable should Articling Surveyor 2 deem it so.

I consent to my articling contract with Articling Surveyor 1 be cancelled.

_____ _____

Articling Student Date

I consent to my articling contract with Articling Student be cancelled.

_____ _____

Articling Surveyor 1 Date

Appendix E

Articling Contract

Appendix F

AERC Academic Evaluation Procedures

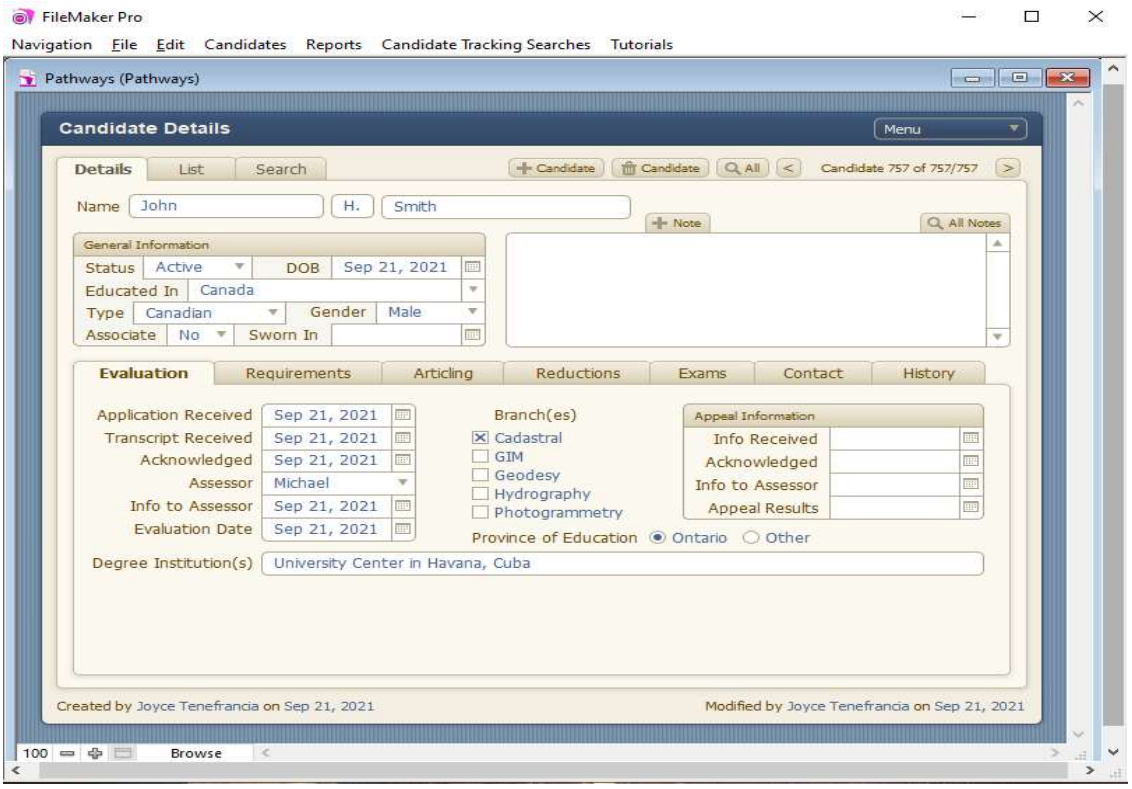
Initial Contact:

An applicant/candidate to contact the AOLS:

1) An initial interview (in person, by email or by phone) is arranged.
   a) If applicable, advise the applicant of the Canadian Language Benchmarks (CLB) tool to assess his/her English language proficiency.
2) Data is collected:
   - Address
   - E-mail
   - Phone
   - Education background
   - Employment
   - etc.
3) The Application
   a) Direct the Applicant to the AOLS Website
   b) Review the Application
   c) Advise the candidate if further documentation is required
   d) Internationally educated professionals will be required to submit the following:
      - They must first apply to either the Comparative Education Service (CES) of the University of Toronto or the World Education Services (WES) and request a "document by document" evaluation from one of these services to be submitted with the application to the AOLS.
4) The evaluation application will be processed if the following is submitted to the AOLS:
   - Payment of the prescribed fee.
   - A cover letter
   - Completed Academic Evaluation Application Form
   - Detailed résumé
   - Official transcript
   - Detailed course descriptions*
5) Once the application package is complete it will be sent to the lead assessor and will be entered in the AOLS Pathways Database as follows:
   a) Name
   b) Last name
   c) Application Date

d) Current Address
e) Country of origin
f) Education
g) Name of educational institution
h) Degree/Diploma
i) Year Conferred

6) If the applicant cannot provide the course descriptions from their educational institution for any reason, if possible; and with the help of the pathways DB (image below), a copy of the course descriptions from the same educational institution and during the same timeframe, will be scanned and forwarded to the lead assessor.



7) If the package has errors, omissions or other issues, the assessor will contact the candidate directly or through the AOLS staff.
8) When the required changes have been made it is resubmitted and forwarded to the Assessor.
9) The Assessor reviews the Application/files.
   a) Transcripts and supporting documents are reviewed.
      i) Courses in the transcript are compared against existing AERC requirements

10) An interview is arranged between the applicant and the Assessor.
    a) Clarifications, editing, amplification etc. can happen during or after the meeting.
    b) Re-submitting, if required is completed.
11) The Assessor prepares an AERC report.
12) The Assessor sends a preliminary assessment to the candidate.
13) Correspond with applicant
14) Assist the applicant with finalizing course selection for replacement courses at other institutions.
    a) Equivalent courses are reviewed and compared to the description of accepted courses.
    b) Determine if the precedent exists,
    c) If precedent exists, accept it;
    d) if no precedent exists, review the course description and compare it against applicable learning outcomes.
15) Finalize the assessment and submit the assessment to the AERC.
16) In the case of an appeal of an academic evaluation, additional information (e.g., course descriptions) would be requested from the candidate. This information would be compared against the AERC requirements.

Appendix G

CBEPS Academic Requirements Accepted by AERC

Date Approved:	2022-10-24	AERC Motion	22-156

C1: Mathematics and Science

C1: MATHEMATICS AND SCIENCE

LEARNING OBJECTIVES

- **Establish the foundational knowledge in math, physics and computing required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
PROBABILITY AND STATISTICS	Surveyors must be able to deal with errors and uncertainty	• Probability theory: Samples, sample spaces, counting (Combinations, permutations) conditional probability, independence of events • Random variables and discrete and continuous distributions: binomial distribution, normal distribution, • Probability density functions and cumulative distribution functions, • Expected values, covariance and correlation • Distribution of the sample mean • Distribution of a linear combination, variance-covariance propagation • Error Sources • Hypothesis testing	**Competencies** • Understand the ideas of random variables, independent and dependent samples, and related probabilities • Visualize random variables as probability distributions and related probability distributions to mean values and confidence regions • Know when to use which distributions and which tests • Recognize the existence of Type I and Type II errors in hypothesis testing • Recognize the probability density function plots for distributions such as normal, Student's t, chi-squared, and Fisher **Learning Outcomes** • Choose appropriate error models and corresponding probability distributions for different types of surveying observations • Compute statistics and visualize data • Generate frequency, relative frequency (or probability), and probability density histograms

			• Apply a cumulative distribution function in order to compute probability values for given critical values of a specified distribution • Apply an inverse cumulative distribution function in order to extract critical values for given probability values of a specified distribution • Compute central tendency measures such as median, mode, and mean of a sample • Compute spread measures such as range, percentiles, variance, and standard deviation • Convert an arbitrary normal random variance with specific mean and standard deviation to standardized normal distribution • Differentiate between confidence and significance levels • Compute covariances and correlation coefficients for pairs of multivariate quantities • Compute confidence intervals for the mean, for the population variance, and for the ratio of two population variances • Differentiate between systematic, random, and gross errors in observations • Identify the source of errors (e.g., the environment, the data collection instrument, and/or the operator) • Conduct a test of hypothesis for the population mean, for the population variance, and the ratio of two population variances

C1: MATHEMATICS AND SCIENCE

LEARNING OBJECTIVES

- **Establish the foundational knowledge in math, physics and computing required to be a surveyor**
- **Support subsequent learning**

Key Principle	Motivation	Syllabus Items	Competencies and Learning Outcomes
NUMERICAL METHODS	Surveyors must deal with numerical data because not all problems can be solved analytically	• Fundamentals of numerical methods; visualize, explore and then model • Numerical errors • Significant figures and reporting precision • Systems of linear equations • Interpolation and extrapolation • Numerical integration • Numerical aspects of solving systems of equations (least squares and the effects of geometry) • Matrix bandwidth concepts and relationship to solution methods and covariances • Concepts of matrix inversion including characteristics of non-singular matrices • Concepts of matrix rank and condition numbers using eigenvalues • Concepts of rank deficiency and full rank • Methods for overcoming rank defects in normal equation matrices • Concepts of Design and Jacobian coefficient matrices and their relationship to the geometry of surveying-related problems • Computation methods for initial approximation for unknown quantities (graphical, numerical, etc.) • Determination of convergence criteria	**Competencies** • Know why you choose which method by understanding the impact of numerical errors • Know how your choices can be affected by numeric layers **Learning Outcomes** • Correctly apply appropriate numerical methods to solve problems and meet required precision • Apply the rules of significant figures to determine the number of significant figures in a number • Demonstrate appropriate representation of data and results • Differentiate between analytical and numerical solutions to a problem • Convert between binary and decimal number representations and vice versa • Describe typical storage of floating point numbers in a computer system (e.g., single and double precision) • Explain terms such as overflow, underflow, machine precision, and round-off, chopping and truncation errors • Approximate order of magnitude for truncation error in Taylor series expansion • Mitigate unavoidable numerical errors in finite precision arithmetic especially for catastrophic/subtractive cancellation scenarios • Estimate absolute and relative (percent) error with respect to a reference value for various purposes including setting convergence criteria in iterative algorithms

			• Set up and solve a ‘small’ system of linear equations via elimination, decomposition/factorization and/or matrix inversion methods • Check a system of linear equations for rank deficiency and numerical ill-conditioning • Fit a data set to a simple curve such as a line, a quadratic or a cubic via linear least squares regression • Differentiate between interpolation and extrapolation • Perform interpolation on ‘small’ data sets using various methods (e.g., nearest neighbour interpolation or interpolating polynomials) • Perform interpolation on ‘large’ data sets using splines (e.g., quadratic or cubic) in order to avoid Runge’s phenomenon • Perform interpolation on ‘large’ data sets using linear, quadratic and/or cubic splines in order to avoid Runge’s phenomenon • Apply numerical differentiation for computing velocity and acceleration from a series of given positions • Apply numerical integration methods for computing areas and volumes • Plot results including appropriate title, axis labels, and units (graphical representation of numerical solutions) • Tabulate results including appropriate significant figures and units • Solve a 'large' system of linear equations via already existing computational libraries

C1: MATHEMATICS AND SCIENCE

LEARNING OBJECTIVES

- **Establish the foundational knowledge in math, physics and computing required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
CALCULUS	Used to solve real-world problems Required to get the results that subsequently get solved with linear algebra	• Functions, continuity & limits • Differentiation & applications • Integration, quadratures & applications • Plane curves, tangency & curvature • Sequences, series & Taylor series expansions • Partial differentiation & differential operators • Multiple integrals & numerical approximations • Homogeneous ordinary differential equations	**Competencies** • Understand the importance, impact and application of using calculus to solve real-world problems • Appreciate the concept of small and continuous changes in inputs leading to small and continuous changes in outputs and how this relates to partial derivatives in both variance propagation equations and in least-squares estimation. • Understand the relationship between systems of first order ordinary differential equations and the state-space model used estimation. **Learning Outcomes** • Use calculus results to solve other problems (i.e. error propagation) • Define & describe mathematical functions • Define & illustrate continuity of a function at one point • Define & evaluate mathematical limits • Define differentiability of a function at one point • Differentiate simple functions • Interpret the derivatives of a function • Define & describe integration of a function • Integrate simple functions • Describe indefinite & definite integrals • Evaluate numerically definite integrals • Formulate representations of plane curves • Describe the tangent to a curve at one point • Describe the curvature of a curve at one point • Describe sequences and series • Define convergence of sequences and series

			• Formulate tests of convergence for sequences and series • Perform Taylor series expansions of simple functions • Define and describe partial differentiation • Partially differentiate simple functions • Define gradient and Laplacian operations and describe their applications • Define and describe multiple indefinite and definite integrals • Describe numerical approximation techniques for multiple integrals • Describe ordinary differential equations and their use in describing position and velocity as a function of time.

C1: MATHEMATICS AND SCIENCE LEARNING OBJECTIVES ● **Establish the foundational knowledge in math, physics and computing required to be a surveyor** ● **Support subsequent learning**			
Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
MATRICES & LINEAR ALGEBRA	Surveyors estimate features with positions using observations; linear algebra is the tool used for estimating multiple unknowns	**Vector operations & analytical geometry** ● Real and complex vectors ● Scalar and vector products of vectors ● Analytical geometry equations and formulae **Matrix algebra, linear equations & transformations** ● Matrices and simple matrix algebra ● Matrix representation of linear algebraic equations and solutions ● Matrix representation of linear transformations **Complex variables, linear spaces & subspaces** ● Complex variables ● Linear real and complex spaces and subspaces ● Projections in real and complex spaces **Quadratic forms, orthogonal & unitary matrices** ● Quadratic forms and applications ● Orthogonal and unitary matrices and their applications **Eigen vectors & values**	**Competencies** ● Understand the geometric interpretation of linear algebra **Learning Outcomes** ● Populate vectors and matrices to perform certain vector/matrix operations ● Perform matrix partition ● Compute the trace of a square matrix ● Solve systems of equations ● Differentiate between row and column vectors ● Compute the magnitude of a vector ● Normalize a vector ● Perform vector operations such as scaling, addition, dot product, and cross product ● Find an angle between two vectors using their dot product ● Project a vector onto another ● Compute the eigenvalues and eigenvectors of a square matrix ● Complete a vector triad using the cross product of two orthogonal vectors ● Identify matrix dimensions ● Perform matrix operations such as scaling, addition, multiplication, transposition ● Compute the determinant of 2D and 3D matrices ● Invert 2D and 3D matrices by hand and/or with a calculator ● Recognize special types of matrices such as rectangular, square, symmetric, diagonal, block diagonal, identity, etc. ● Convert a system of equations into vector and matrix form and vice versa ● Detect whether a system is rank deficient (i.e., singular)

			• Compute the norm and condition number of a matrix • Perform a transformation of a vector or matrix of coordinates from one system to another using a scaling factor, translation vector, and a rotation matrix • Differentiate vector and/or matrix expressions w.r.t. a vector with parameters of interest using the numerator convention (also known as the Jacobian notation)

C1: MATHEMATICS AND SCIENCE

LEARNING OBJECTIVES

- **Establish the foundational knowledge in math, physics and computing required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
PHYSICS	Surveyors use measuring technologies that rely on certain physics principles	• Units of measure ○ SI system of units of measure • Vectors and Scalars • Kinematics and dynamics • Optics (i.e. geometric and physical) • Electricity and Magnetism Waves • Energy, Acoustics and Wave Motion • Physics of the Earth (expand - too general)	**Competencies** • Understand the laws of physics and how they enable and affect measuring technologies • Understand the Système International (SI) system of units of measure in quantity representations for; area, distance (length), frequency, volume, mass, time, electric current, force, energy, gravity and temperature; • Know the terms: mass, time, distance, force, acceleration, momentum, gravity, pressure; • Understand Newton's Laws of motion • Know electric current terms; such as, volts, watts, ampere, charge, capacitance (Farads), potential difference, and resistance(ohms); • Understand and use the laws of reflection and refraction; • Know the speed of sound, and the speed of light; • Know the terms: humidity, absolute humidity, relative humidity, saturation vapour pressure, equilibrium state • Know the atmospheric layers: ionosphere, mesosphere, stratosphere, troposphere, thermosphere, from earth's surface • Understand Kepler's Laws of planetary motion (universal gravitation, gravitational field, orbital dynamics); • Understand spheroidal oscillations in elastic waves and seismic rays at earth's surface; • Understand physics of the atmosphere and their effect on electromagnetic waves and measurements; **Learning Outcomes**

			• Carry out calculations symbolically and numerically • Use unit analysis to verify results/validity of equations • Describe physical quantity of anything that may be defined and measured; • Describe vectors quantities and magnitude and scalars quantities in magnitude • Perform vector addition graphically and mathematically and describe vector positions in coordinate systems • Perform linear motion calculations; • Perform speed calculation of objects (example; speed of a satellite orbiting the earth); • Perform calculations in: Work, Power, Uniform Circular Motion, Gravitational motion, and simple machines; • Describe Snell's Law; • Describe the conditions under which total internal reflection occurs; • Define different types of optical lens and find the focal length and power of a lens; • The use of Ray Diagrams and lens equation to find the position of objects and images; • Calculate magnification and angular magnification; • Describe the telescope as an optical instrument; • Describe circular wave patterns in sound wave; • Describe Moire pattern in sound propagation; • Describe sound intensity; • Explain sound wave equation variables. • Describe Gauss's Law and Coulomb's Law; • Calculate the energy and power supplied to electrical components; • Calculate magnetic flux density adjacent to wires carrying currents; • Describe Faraday's Law and Lenz's Law; • Describe the use of Maxwell's Equations; • Calculate the force on a moving charged particle; • Calculate the force between parallel wires carrying a current; • Calculate the value of the permeability of free space from the definition of the ampere; • Calculate the torque on a rectangular coil carrying a current in a magnetic field; • Describe light and sound as waves, and their wave motion; • Describe stationary wave and know how stationary waves are formed; • Describe wave harmonics;

			• Explain the terms interference and diffraction of waves (doppler effect, resonance); • Explain oscillatory of waves (periodic motion, extension); • Describe the principle of superposition of waves; • Explain the difference between Amplitude Modulation (AM), Frequency Modulation (FM), and Phase Modulation (PM); • Explain energy sources and radiation principles; • Describe the electromagnetic spectrum; • Describe energy interactions with the earth's surface and the atmosphere; • Explain spectral reflectance and response patterns from natural objects • Use the Gauss coefficients in determining geomagnetic field; • Express gravity as gradient of earth's geopotential; • Calculate the velocity of electromagnetic energy as a rate of energy propagates through the atmosphere.

C1: MATHEMATICS AND SCIENCE

LEARNING OBJECTIVES

- **Establish the foundational knowledge in math, physics and computing required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
COMPUTING	Surveyors are dealing with increasingly large data sets and need to be able to use software to process and manage data	• Data types • Logic • Algorithms • Functions • Input/output • Simple program design • Variables, functions and operators • Boolean logic • Concepts of numerical representation (e.g., binary versus decimal) • Concepts of internal representation (e.g., bits, bytes, etc.) • Concepts of sign, mantissa, exponent storage requirements • Concepts of computational precision	**Competencies** • Understand the methods used in commercial software packages (COTS) • Be able to translate problems to computer solvable programs • Develop strategies to manage data at all stages of Land Surveying work from acquisition to inclusion in final products, to long-term archiving. This may include preprocessing, quality assurance, converting, formatting for use with different COTS software, submission with Land Surveying products. **Learning Outcomes** • Understand the procedures involved in developing algorithms • Translate surveying problems into computer language • Understand the basics of functions, arrays and records • Solve problems using computer programming • Write simple functions to read and write ASCII and binary data from and to files appropriately formatted files

C2: MODELING AND ANALYSIS

LEARNING OBJECTIVES

- **Establish the fundamental knowledge of modeling and analysis required in surveying**
- **Support subsequent learning**

Key Principle	Motivation	Syllabus Items	Competencies and Learning Outcomes
MODELING AND PREDICTION	Surveyors must know how to use modeling and prediction to derive useful information from measurements	• Fundamentals of spatial data analysis; visualise, explore and then model • Conditional, parametric, and general models • Least squares adjustment models for different geomatics observables (distance, azimuth, direction, levelling, GNSS, etc.) • Modeling of time series (Fourier Series – Discrete, Fast Fourier Transforms, Wavelets) • Simple prediction model as a component of Kalman filtering • Sequential adjustment model • Manipulation of normal equations in adjustments • Comparison of multi-epoch estimated parameters and associated variance-covariance estimates • Concepts of deformation analysis for multi-epoch estimation	**Competencies** • Describe the different types of models, their characteristics, and how to derive them • Justify the selection of models of survey measurements **Learning Outcomes** • Formulate models for ellipsoidal, spherical, and conformal mapping plane representations of the earth • Derive least squares adjustment models (conditional, parametric, and general) for geomatics problems, such as levelling, traverse, triangulation and trilateration networks • Transform coordinates from local system to real world coordinate system, such as UTM, and use the transformation as prediction model • Model time and spatial data series for further analysis, e.g. for deformation analysis, etc.

C2: Modelling and Analysis

C2: MODELING AND ANALYSIS **LEARNING OBJECTIVES** ● **Establish the fundamental knowledge of modeling and analysis required in surveying** ● **Support subsequent learning**			
Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
ESTIMATION AND APPROXIMATION	Surveyors must be able to quantitatively evaluate parameters or functions from measurements that have random component	● Overdetermined system of equations ● Datum problems, including datum transformation ● Adjustment calculus principle ● Principles and properties of least squares estimation ● Least squares approximation ● Calculus as applied to linearize non-linear systems of equations ● Matrix manipulation involved in estimation and approximation ● Concepts of variance-covariance estimation ● Weighting and inverse relationship to variance-covarance matrices ● Concept of a cofactor matrix and the aprior standard variance ● Estimation of aposteriori standard variance ● Weighted parameter least squares ● Phased least squares solutions with added and removed observations ● Variance component estimationConcepts of minimally- and over-constrained solutions ● Concepts of multi-epoch deformation analysis ● Stress and strain analysis in deformation analysis	**Competencies** ● Describe the least squares estimation principles, properties, and steps, from model formulation to solution stage ● Construct curves or mathematical functions, which best fit to series of data points ● Evaluate the impacts of different variables (human, instrumental, atmospheric conditions, ground instability, etc.) on measurements relating to equipment calibration, etc. ● Perform pre-analysis and applying statistical analysis. **Learning Outcomes** ● Apply matrix theory in estimation and approximation problems ● Apply least squares adjustment principle to solve geomatics problems (compute the parameter vector and its variance-covariance matrix), such as levelling, traverse, triangulation and trilateration networks ● Perform partitioned least squares adjustments to eliminate nuisance parameters from measurements ● Apply error propagation approach to determine quality of approximated functions and estimated parameters ● Solve over-constrained and free network (including inner-constrained) adjustment problems ● Analyze systematic and random errors in measurements and equipment, and their impacts on estimated parameters, such as in equipment calibration

			• Apply regression analysis to geomatics problems, such as equipment calibration and time series

C2: MODELING AND ANALYSIS

LEARNING OBJECTIVES

- **Establish the fundamental knowledge of modeling and analysis required in surveying**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
FILTERING	Surveyors must be able to screen (filter) out unwanted variations in signal to account for major variations in the signal	• Spectral analysis of time series • Relationship between sequential least squares adjustments and filtering • Relationship between spectral analysis of time series and filtering • Finite Impulse Response (FIR) filter design methods in image processing • Other filtering algorithms, such as used in positioning problems, e.g. Kalman filtering	**Competencies** • Perform spectral analysis • Design and use various filters • Describe the relationship between spectral analysis and filtering • Describe the relationship between sequential least squares adjustment and filtering • Describe the principles of a Kalman filter **Learning Outcomes** • Perform spectral analysis of a signal • Identify the spectral components of a signal to be filtered/retained • Design and use various FIR filters (lowpass, highpass, bandpass, derivative, etc.) for a problem

C2: MODELING AND ANALYSIS LEARNING OBJECTIVES			
Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
STATISTICAL DATA ANALYSIS	Surveyors must be able to organize, interpret and evaluate survey measurements and the parameters based on those measurements	• Error propagation law and pre-analysis of geomatics networks • Probability and statistics to assess quality of geomatics measurements • Probability and statistics to assess quality of adjustment solutions • Concepts of underdetermined, uniquely determined and overdetemined systems • Concepts of redundancy and absorption numbers • Computation of reduancy and absorportion numbers • Concepts of error intervals, ellipses and ellipsoids • Relationship between geometry, observational variance-covariance on error intervals, ellipse and ellipsoid analysis	**Competencies** • Describe the different types of errors and their characteristics, including how they are propagated • Apply the law of random error propagation to determine variance-covariance matrices of measurements and adjusted quantities • Construct confidence regions for measurements • Organize, interpret and statistically evaluate survey measurements and the possible estimated parameters **Learning Outcomes** • Apply law of random error propagation to levelling and traverse tasks and similar problems to predict misclosure errors based on the precision of the instruments to be used and the precision of the control network(s) • Conduct network design and pre-analysis for GNSS and traditional surveys by following appropriate specifications and guidelines • Compute and analyze redundancy (and absorption) numbers, internal reliability and external reliability of geodetic network • Estimate the variance factor of an adjustment and evaluate its quality, e.g. in blunder (outlier) detection • Perform statistical hypothesis tests on mean and variance to detect and identify outliers (blunders) in observations • Perform statistical hypothesis tests using appropriate distributions (normal, Chi-square, Student's t, F statistics, and Pope's tau) • Compute and analyze variance components • Estimate residuals of an adjustment (including histogram plot) and statistically analyse them for possible outlier • Apply the concepts of confidence intervals and absolute and relative error ellipses to express quality of surveys

			• Determine and evaluate local, network, internal and external accuracies of surveys • Determine the confidence level and error probability of statistical decisions (with appropriate definitions of significance level, power of test, type I and type II errors)

C3: Geodesy

COMPONENT 3: GEODESY **LEARNING OBJECTIVES** **Establish the fundamental knowledge in reference systems (coordinate systems & time systems), geodetic positioning process (conventional, and satellite), map projection systems**			
Key Principles	Motivation	Syllabus Items	Competencies and /Learning Outcomes

REFERENCE SYSTEMS, GEODETIC COORDINATE COMPUTATIONS AND MAP PROJECTIONS	Surveyors need to understand the fundamentals of reference systems and be able to compute coordinates and transform between systems as appropriate.	• History and Relevance
		  ○ Definition, Branches, Categories
		  ○ Uses
		  ○ Relation to the other Scientific Disciplines
		  ○ Relevant National and International Organizations
		• Earth and Its Motions
		  ○ Annual & Diurnal
		  ○ Precession
		  ○ Nutation
		  ○ Free Nutation (Polar Motion)
		• Earth and Its Deformation in Time
		  ○ Tide
		  ○ Theory of Isostasy (Equilibrium)
		  ○ Post Glacial Rebound
		  ○ Plate Tectonics
		• Earth and Its Atmosphere
		  ○ Physical Properties
		  ○ Wave Propagation
		  o Temporal Variations
		  ○ Gravitational Field
		• Reference System fundamentals
		• Two dimensional (2D)
		• Three dimensional (3D)
		• Cartesian and Polar representations
		• Coordinate tansofrmations in 2D and 3D
			Competencies
			• Identify appropriate reference systems for different observation types
			• Apply corrections and reductions to terrestrial observations for gravitational and geometrical effects
			• Identify the geodetic processes used in datum realizations
			• Implement forward and inverse coordinate computations on a reference surface and in three dimensions
			• Identify and apply the necessary mathematical processes to move between different reference systems
			• Distinguish different geodetic reference systems and use them in real-world situations
			• Differentiate the properties, advantages, and disadvantages of map projections in North America to apply the relevant system to survey projects
			• Develop and employ processes for geodetic coordinate computations in reference systems and projections of different kinds by prescribing the necessary mathematical processes
			• Use processes for transforming data into appropriate reference systems and coordinates
			• Evaluate projected data by applying an understanding of distortions in map projections (conformal, equivalence, equidistance, planar) and how distortions are represented mathematically
			• Perform ground to map projection system transformation and vice-versa
			• Demonstrate when and how geodetic positioning processes should be applied using real world examples (observations,

		• Reference Systems (Definitions, Realizations and Transformations)
		  ○ Terrestrial
		  ○ Celestial
		  ○ Orbital
		  ○ Time
		• Reductions of Conventional Geodetic Measurements to the Reference EllipsoidCoordinate Computations
		  ○ 2D (spherical and ellipsoidal approximations)
		  ○ 3D
		  ○ Astronomic
		• Map Projection Systems
		  ○ Surfaces and Distortions
		  ○ Concepts of a Tissot indicatrix
		  ○ Classification of Map Projection Systems
		  ○ Cylindrical, Conic and Stereographic Map Projections
		  ○ Coordinate Computations on Map Projection Systems
		  ○ Coordinate Transformations (Ground to Map Projection and vice versa)
		  ○ Concepts of false Eastings and Northings
		  ○ Convergence of meridians
		  ○ Scale factor calculation (e.g., UTM, MTM)
			corrections, reductions, position computations on ellipsoid, and projection on the mapping plane)
			• Differentiate alternative reference systems and projections for observation, processing, and presentation of results
			
			Learning outcomes
			
			• Summarize the history of geodesy and its relevance to the current practice of geomatics engineering
			• Describe organizations related to reference systems and frames
			• Identify and assess relevance of earth motions and deformations to positioning tasks
			• Demonstrate how to use astronomical observations for computing latitude, longitude and azimuth
			• Explain why reference systems evolve over time and how to deal with the effects
			• Describe the problems of map projections and the surfaces involved in map projections and the fundamental equations of those surfaces
			• Distinguish different reference systems used in geodesy
			• Determine how to apply geodetic reference systems to real-world situations
			• Select the appropriate coordinate system to be used in the support of a specific geodetic application and evaluate that choice with reference to limitations and accuracy of the system
			• Distinguish different types of Geodetic Datums, Spatial Reference Frames and Systems used in North America
			• Evaluate reference systems and anticipated reference frame realizations

COMPONENT 3: GEODESY

LEARNING OBJECTIVES

Establish the fundamental knowledge in Earth's gravity field, geoid computations, vertical datum, height systems

Key Principle	Motivation	Syllabus Items	Competencies and Learning Outcomes

GRAVITY FIELD AND HEIGHT SYSTEMS	Earth's gravity field has a direct effect on all survey measurements as well as on the geoid.
	
	Earth's gravity field is used as a reference for positions, especially elevations
		• Earth's Gravity Field
		• Gravity Measurements
		  ○ Satellite
		  ○ Terrestrial
		• Gravity Fundamentals and Characteristics
		  ○ Real and Normal Gravity
		  ○ Equipotential Surfaces
		• Geoid Computation
		• Gravimetric and Astro-Geodetic Geoid
		• Mean Sea Level & Sea Surface Topography
		  ○ Tide Gauges
		  ○ Satellite Altimetry
		• Geodetic Leveling
		• Height Systems and Transformations
		• Vertical Datum
		  ○ Geoidal Models
		  ○ Leveling Based Datums
		  ○ Ellipsoid
			Competencies
			
			• Evaluate observations and data in relation to earth's gravity field
			• Use knowledge of the relationship between deflection of vertical, gravity field, and geoid to interpret and transform surveying observations
			• Implement the vertical or 3rd dimension of coordinate systems
			• Distinguish between vertical datums and geoid models used in North America
			• Apply transformation processes to convert between vertical reference systems
			• Distinguish geoid from mean sea level, and interpret tide gauge observations and other sea surface information in the context of sea surface topography
			• Differentiate realizations of vertical reference systems used in Canada in terms of accuracy and suitability for different project types
			• Develop processes for converting observations between vertical reference systems and their realizations, including identifying and retrieving information needed to execute transformations
			• Explain mathematically how the gravity field of the Earth is measured, the geoid is computed, and relate this to different height systems
			
			Learning outcomes
			
			• Compute heights in different height systems
			• Describe how fundamentals of the Earth's gravity field are applied to surveying techniques and computation

			• Describe and evaluate the impact of gravity on measurements and on reference systems • Demonstrate the relationship between equipotential surfaces and gravity field to determine survey requirements at different scales • Evaluate alternative height systems to determine their suitability for different project types • Assess quality of geoid- or levelling-based vertical reference systems based on available gravity or levelling observations, computational processes, and properties of Earth's gravity field • Identify, compare and differentiate between height systems

COMPONENT 3: GEODESY **LEARNING OBJECTIVES** **Establish the fundamental knowledge in Satellite Geodesy and Its Application in Surveying and Mapping**			
Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes

SATELLITE POSITIONING SYSTEMS	Global Navigation Satellite System (GNSS) is an important tool in surveying; it is important to be able to associate the right tool to the right task by understanding the advantages and limitations that GNSS provides	• Development and Evolution of Satellite Systems (strengths and limitations)
		• System Components
		• Positioning Modes
		  ○ Point/Differential
		  ○ Post-Processing/Real-Time
		  ○ Static/kinematic
		• Satellite Signals
		  ○ EM Propagation and Modulation Techniques
		  ○ Basic Signal Structure
		  ○ Signal Modernization
		• Receivers' hardware components
		• Observation Types & Equations
		• Errors and Biases and Mitigation Strategies
		  ○ Satellite Based
		  ○ Signal Propagation Media based
		  ○ Receiver Based
		• Solutions
		  ○ Point Positioning
		  ○ Differential Positioning
		  ○ Other Types of Observation Combination
		• Types and Applications of Adjustment
		• Coordinate Transformation
		• Interoperability (Data Formats)
		• GNSS Networks in North America and around the World (CACS, CORS, IGS)
		• GNSS Network Establishment Consideration
		• GNSS Data Processing Algorithms
			Competencies
			
			• Evaluate, correct and process GNSS observations
			• Distinguish different types of GNSS observations (pseudo-range, and phase), their characteristics, and their corresponding mathematical models
			• Describe the basic elements, concepts and configuration of satellite systems and their relevance to the survey profession
			• Identify error sources, biases and achievable accuracy associated with each positioning mode to apply appropriate mitigation strategies
			• Describe, compare, and differentiate between different GNSS positioning modes and implement the appropriate mode for applications
			
			Learning outcomes
			
			• Plan and implement specific procedures for using high precision GNSS
			• Implement processes to cancel and/or mitigate GNSS errors and biases in different applications
			• Describe and evaluate the strengths and limitations of different GNSS constellations
			• Describe complications of electromagnetic wave propagation in the conditions of ranging from an extra-terrestrial source to the surface of the Earth

			• Identify the basic elements, concepts and configuration of satellite systems including some of the common terms relevant to surveying • Identify the error sources and evaluate achievable accuracy associated with each GNSS positioning method • Describe GNSS network considerations and relate them to GNSS network adjustments • Describe Virtual Reference System (VRS) and Satellite Based Augmented Systems (SBAS)

C4: Surveying

C4: SURVEYING LEARNING OBJECTIVES • **Establish foundational knowledge of surveying operations**			
Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
INSTRUMENTATION TESTING & UTILIZATION	Understanding the equipment is fundamental to all surveying tasks	• Development and implications of historical survey instruments • Elements and operational principles of elevation determination instruments • Elements and operational principles of angle measurements instruments • Elements and operational principles of distance measurement instruments • Elements and operational principles of GPS/GNSS receiver (for ground surveys) • Elements and operational principles of 3D scanner • Elements and operational principles of unmanned aerial vehicle (UAV) • Ancillary equipment (measuring tapes, plumb bobs, rods, external data collectors, etc.) • Elements and operational principles of instruments for azimuth determination • Calibration of instruments • Field methods for instrument testing • Peg field tests and calibration baselines	**Competencies** • Identify different eras of survey instrumentation and the impact on results • Interpret technical specifications of equipment • Use instruments properly (set up and use) for various types of surveying **Learning Outcomes** • Choose the appropriate procedures and quality assurance measures for maintenance, testing and calibration of surveying instruments • Identify the salient components of surveying instruments • Select the right instrument (what it is for) • Practice necessary field testing and calibration of instruments

COMPONENT 4: SURVEYING

LEARNING OBJECTIVES

- **Establish foundational knowledge of surveying operations**

Key Principle	Motivation	Syllabus Items	Competencies and Learning Outcomes
OBSERVABLE TYPES & QUALITY ASSESSMENT	Observations are needed to measure positions on the Earth's surface	• Errors and mistakes, accuracy and precision in measurements • Random, systematic errors and blunders • Basic observables: slope distances, horizontal directions/angles, vertical angles, vertical distances • Derived measurements: coordinates, elevation differences, horizontal and mark-to-mark distances, horizontal angles, azimuths derived from plane, astronomic, geodetic, gyro theodolite or gyro station measurements • Characteristics of raw data	**Competencies** • Ensure data output makes sense • Reality check of what the instruments are saying (correct) – are the numbers reasonable? • Think beyond the black box • Recognize errors in all observations • Use instruments properly for taking measurements **Learning Outcomes** • Estimate accuracy and precision • Apply quality assurance/quality control checks on measurements • Identify sources of information and errors • Explain the concept of precision as it relates to surveying processes – sources and types of random errors and their quantification • Explain the concept of accuracy as it relates to surveying processes – sources and types of systematic errors and how to address them

COMPONENT 4: SURVEYING

LEARNING OBJECTIVES

- **Establish foundational knowledge of surveying operations**

Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
DATA COLLECTION INCLUDING FIELD PROCEDURES	Quality of measurements depends on well-designed and executed field procedures a	• Basic principles and procedures of angular and direction measurement • Basic principles and procedures of distance measurement • Basic principles and procedures of differential leveling • COGO geometry • Basic principles and procedures of trigonometric heighting • Procedures and calculation of location by intersection and resection • Basic principles, procedures and computation of traversing • Procedures and calculation of construction layout • Basic principles, procedures and computation of route survey (horizontal & vertical curves) • Principles of field notes, field records and significant numbers • Principles and procedures of field checks • Concepts of redundancy for error checking	**Competencies** • Explain handling of refraction effects • Recognize error propagation • Use modern instrumentation, data collection techniques, and equipment to conduct experiments and obtain valid data • Justify the use of the right tool and instrumentation settings **Learning Outcomes** • Calibrate an EDM on a baseline, analyse and explain the propagation of errors due to the precision of the EDM and meteorological instruments used in the process and compare the expected error and actual error from the baseline survey. Analyze if there is deformation in the baseline pillars. • Practice adjustment of misclosure • Apply proper procedures and technical specifications to minimize or mitigate errors • Assess the accuracy and precision of results • Translate specification such as maximum allowable misclosures into a choice of equipment and procedures for horizontal, height or 3-dimensional traversing • Compose specifications and requirements for gathering survey related data • Convey/communicate accurately and effectively site data through data collectors and field notes

COMPONENT 4: SURVEYING LEARNING OBJECTIVES ● Establish foundational knowledge of surveying operations			
Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
COMMON SURVEY TYPES (CADASTRAL, TOPOGRAPHIC, CONTROL, ETC.)	Different application areas have different requirements for surveying Surveyors need to know which type of survey is used for each project	● Survey types ○ Cadastral survey ○ Construction survey ○ Location survey ○ Floodplain mapping ○ Site planning survey ○ Topographic survey ○ Control survey ○ Oil and gas survey ○ Mining survey ○ Underground survey ○ Deformation survey ○ Offshore engineering survey ○ Introduction to hydrographic surveys	**Competencies** ● Assess different types of surveys to make appropriate selections for the project ● Comply with legislation and regulations related to each type of survey and jurisdiction **Learning Outcomes** ● Compare/contrast common types of surveys ● Design proper field procedures for the intended survey ● Explain the procedures for each type of survey

COMPONENT 4: SURVEYING

LEARNING OBJECTIVES

- **Establish foundational knowledge of surveying operations**

Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
SURVEY DESIGN, SIMULATION AND ANALYSIS	Different projects have different requirements for surveying procedures and controls	• Requirements' analysis • principles and steps of survey design and analysis • Errors and consideration in design • Design and analysis of control surveys • Logistical and resource considerations in survey design to meet project needs • Occupational health and safety issues	**Competencies** • Identify the elements that go into survey design and planning • Apply critical thinking to ensure relevant and important details are included in the design and planning steps • Develop an understanding of surveying observations and their errors • Apply knowledge in design of control surveys to efficiently meet client requirements • Design the appropriate combination of equipment and procedures for data collection that ensures the results meet the quality requirements of relative positioning **Learning Outcomes** • Interpret the limitations of both theory and measurement, including precision and accuracy • Design and analyze control surveys

COMPONENT 4: SURVEYING

LEARNING OBJECTIVES

- **Establish foundational knowledge of surveying operations**

Key Principles	Motivation	Syllabus Items	Competencies and Learning Outcomes
HIGH PRECISION SURVEYING	Some projects require high precision measurements	• High-precision instruments • Industrial surveying (or metrology) • Deformation monitoring • Precision construction alignment • High precision leveling • Tunnelling survey • Control Survey • Blunder and outlier detection	**Competencies** • Explain where specific errors are coming from and how to eliminate them • Recommend the utilization of non-traditional survey equipment and procedures • Develop skills in data collection, processing, analysis and interpretation via advanced and complex calculations and computer programming **Learning Outcomes** • Assess and apply the appropriate field procedures, equipment, and processing techniques for specific high-precision surveying tasks • Apply knowledge and skills for establishing geodetic control for engineering projects of high accuracy/precision • Use a range of techniques for managing survey errors and biases including blunder and outlier detection results verification and quality control • Assess the results of any of these survey types • Discriminate the survey types that result in position information and the one that require repeated positioning for local deformation monitoring. • Discuss the implication of repeated measurements for long-term monitoring with respect to systematic and random influences on the measurement systems.

C5: Remote Sensing

<table>
<tr><td colspan="4">C5: REMOTE SENSING

LEARNING OBJECTIVES

● Establish the foundational knowledge in remote sensing required to be a surveyor
● Support subsequent learning</td></tr>
<tr><td>Key Principles</td><td>Motivation</td><td>Syllabus Items</td><td>Competencies/Learning Outcomes</td></tr>
<tr><td>Introduction to Remote Sensing</td><td>Surveyors need to understand remote sensing fundamentals as remote sensing is a frequently used tool for data collection</td><td>● The Electromagnetic Spectrum
○ Characteristics of electromagnetic radiation
○ Atmospheric windows
○ Scattering
○ Reflection
○ Absorption/emission
● Data Models
○ Vector Data
○ Raster Data
○ IFOV and FOV
○ Vector vs Raster
○ Concepts of pixels and voxels
○ Quantization / bit representation of pixels</td><td>Competencies

● Describe sensors, data collection processes and data manipulation to support decision making for survey projects
● Identify benefits and limitations of remotely sensed data
● Describe and explain characteristics of electromagnetic waves, and interaction with the atmosphere and objects on ground
● Describe the fundamental principles of remote sensing and review their application to surveying the advantages and disadvantages of the two data models
● Describe and explain the differences and concepts of vector and raster data

Learning Outcomes

● Compare different type of sensors data.
● Explain fundamental concepts of remote sensing and data models
● Choose appropriate raster data for survey projects</td></tr>
</table>

C5: REMOTE SENSING

LEARNING OBJECTIVES

- **Establish the foundational knowledge in remote sensing) required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes

Remote Sensing Platforms	Remote sensing technology is used by surveyors to do their work; surveyors need to be familiar with the characteristics of available remote sensing platforms	• **Advantages, limitations, and applications of remotely sensed data**
		• **Ground based platforms (Handheld devices, Vehicles, tripods, and towers)**
		  ○ Use of ground-based platform
		  ○ Setting up ground-based platforms
		  ○ Advantages and disadvantages of all platforms
		• **Airborne platforms (RPAS, and Aeroplanes)**
		  ○ Mission planning
		  ○ Calculating flight altitude
		  ○ Calculating number of flight lines
		  ○ Calculating number of images per flight line
		  ○ Calculating platform speed
		  ○ Calculating image scale
		• **Space borne platforms (Satellites)**
		  ○ Law of gravitation
		  ○ Circular motion and satellites
		  ○ Kepler's laws
		  ○ Satellite orbit classification
			Competencies
			• Describe and explain characteristics and theory of remote sensing platforms
			• Recognize the appropriate remote sensing solution for the survey
			• Describe and explain the fundamentals of satellite motion
			Learning Outcomes
			• Review appropriate platform and sensor to capture relevant data to specific projects
			• Identify the data requirements for the specific project
			• Practice airborne mission planning

C5: REMOTE SENSING

LEARNING OBJECTIVES

- **Establish the foundational knowledge in remote sensing required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes

Passive Remote Sensing: Sensors	Remote Sensing technology is used by surveyors to do their work; surveyors must understand basic technology and characteristics of passive imaging sensors	• **Cameras and Scanners**
		  ○ Characteristics, geometry, benefits, and limitations of a digital image
		  ○ Single, stereo and multiple image modes
		• **Image Resolution**
		  ○ Spatial resolution
		  ○ Spectral resolution
		  ○ Radiometric resolution
		  ○ Temporal resolution
			Competencies
			
			• Describe, explain, and illustrate the geometry and characteristics of camera and scanner sensors.
			• Describe the various types of resolutions and demonstrate their role in data quality captured by cameras and scanners
			
			Learning Outcomes
			
			• Identify and review the right sensor/data to meet the survey requirements
			• Demonstrate the role of resolution in data quality captured by cameras and scanners

C5: REMOTE SENSING

LEARNING OBJECTIVES

- **Establish the foundational knowledge in remote sensing) required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes

Passive Remote Sensing: Image Processing and Manipulation	Surveyors need to understand digital image processing and manipulation to understand what they are looking at.
	
	Used for 3D spatial data collection and 2/3D object reconstruction and mapping
		• **Image Processing**
		  ○ Atmospheric corrections
		  ○ Geometric corrections
		  ○ Radiometric corrections
		  ○ Derivations of 3D object metric information from imagery
		  ○ Measurement and correction of image coordinates
		• **Image Enhancement**
		  ○ Contrast stretch
		  ○ Histogram equalization
		  ○ Digital filtering
		  ○ Spatial and spectral filtering
		• **Band Composite**
		  ○ Band combinations of satellite imageries and their applications
		• **Image Manipulation**
		  ○ **Softcopy photogrammetry and image processing**
		  ○ Image rectification
		  ○ DEM and orthoimage generation
		  ○ Coordinate transformations
		  ○ Mathematical models for sensor and for sensor to object relationships
		• **Statistical Characteristics**
		  ○ Resampling methods
		  ○ Image matching methods
		  ○ Close range photogrammetry
		  ○ Digital photogrammetry, epipolar geometry, image matching and 3D reconstruction
			Competencies
			
			• Describe concepts, limitations and benefits of basic image processing, enhancement, and data manipulation techniques
			• Describe the mathematical models relating sensor space to object space
			• Describe and apply DEM and orthoimage generation
			
			Learning Outcomes
			
			• Demonstrate basic image corrections, image enhancement, and band composites
			• apply the mathematical models relating sensor space to object space
			• Test calculations to determine print scale, and size
			• Apply DEM and orthoimage generation

C5: REMOTE SENSING

LEARNING OBJECTIVES

- **Establish the foundational knowledge In remote sensing required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Critical Thinking (must be able to think through) Competency/Learning Outcomes

Passive Remote Sensing: Image Analysis and Interpretation	Surveyors need to understand the outcome of image classification to for product preparation	• **Visual Interpretation**
		  ○ Defining objectives
		  ○ Selecting data
		  ○ Interpretation key
		• **Digital Interpretation**
		  ○ Unsupervised image classification
		  ○ Supervised image classification
		  ○ Object oriented image classification
		  ○ AI methods for data extraction
			Competencies
			
			• Describe and discuss image analysis and interpretation concepts and techniques.
			• Identify appropriate data
			
			Learning Outcomes
			
			• Implement and compare visual and digital imager interpretation
			• Apply and compare the different types of image classification
			• Identify, describe, and apply common image analyses and interpretation techniques

C5: REMOTE SENSING

LEARNING OBJECTIVES

- **Establish the foundational knowledge in remote sensing required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes

Passive Remote Sensing: Applications	Surveyors use remote sensing images and need to be able to leverage remote sensing data for various applications, including base mapping	• **Passive Remote Sensing Applications**
		  ○ Vegetation analysis and mapping using NDVI (Normalized Difference Vegetation Index) and other vegetation indices
		  ○ Land-use/Land-cover applications including built up area mapping, and surface water mapping
		  ○ Forest fire detection and burn area mapping
		  ○ Temporal analysis for change detection
		  ○ Principal Component Analysis (PCA)
		  ○ Topographic mapping
			Competencies
			• Identify and describe common remote sensing data applications
			• Identify, describe, and apply common applications of passive remote sensed data
			• Identify, differentiate, and apply temporal image analysis methods
			Learning Outcomes
			• Apply and compare the various vegetation indices
			• Implement and analyse land use/land cover mapping types

C5: REMOTE SENSING

LEARNING OBJECTIVES

- **Establish the foundational knowledge in remote sensing required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes

Active Remote Sensing Sensors and Applications: LIDAR	Active remote sensing sensors like LIDAR are becoming increasingly popular in geomatics and surveying industry. Surveyors need to know these technologies and their application
	
	LIDAR is used by surveyors for a range of products
		• **Fundamentals of LIDAR technology**
		  ○ Components of LIDAR Systems
		  ○ Determination of 3D Coordinates from LIDAR Systems
		  ○ Calibration
		  ○ Processing of point cloud data
		  ○ 3D point cloud co-registration
		• **Ground based LIDAR Systems**
		  ○ (Terrestrial Laser Scanners–TLS) technology
		  ○ Mission planning and data acquisition using TLS
		  ○ Applications of TLS (Scanning of buildings and structures)
		• **Airborne LIDAR Systems**
		  ○ Airborne LIDAR Technology (GNSS, IMU, Laser Scanner)
		  ○ Mission planning and flying operation
		  ○ Geolocation Process
		  ○ Sources of Data Errors
		  ○ Applications of Airborne LIDAR systems (DEM, DSM, volume calculation, view shed and watershed area determination)
		• **Spaceborne LIDAR System**
		  ○ ICESAT-2
		  ○ GEDI
		• **LIDAR Applications**
		  ○ Use in Land Surveying
		  ○ Generation of Digital Terrain Models (DTMs)
		  ○ Open Pit Volume Calculations
		  ○ Transportation Expansion
		  ○ Tunnel mapping
		  ○ Corridor mapping
			Competencies
			
			• Identify and describe common LIDAR systems, including their benefits and limitations
			• Describe and explain, LIDAR technology, and its applications
			• Describe and explain various coordinates systems involved and how the final object coordinates are determined from the LIDAR system
			• Describe beam reflection mechanisms
			• Identify and describe the different laser range finding methods
			
			Learning Outcomes
			
			• Review and Interpret point cloud data and calculate coordinate precision
			• Process point cloud data
			• prepare mission plan and data acquisition for a project
			• Generate a DTM for a project
			• Calculate open pit volumes for a project

C5: REMOTE SENSING

LEARNING OBJECTIVES

- **Establish the foundational knowledge in remote sensing required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes
Active Remote Sensing Sensors: SONAR Technology and Hydrography	Hydrography provides up-to-date nautical charts for safe navigation and the protection of the marine environment. It focuses on the measurements of physical characteristics of water bodies and adjoining coastal areas Surveys that involve water bodies and offshore require knowledge of SONAR, which is actively used in bathymetric surveys	• **Principles and Processes of Hydrographic Surveying and SONAR Technology** ○ Sound waves and their characteristics ○ Refraction of sound waves ○ Propagation of sound waves in water ○ Tidal fundamentals, measurements, streams, and currents ○ Non-tidal water variations ○ Vertical Datum, elevation, and soundings, MLW, MLLW, MHW • **SONAR Systems** ○ Single Beam Echo Sounders (SBES) ○ Narrow Beam and Wide Beam Sounders ○ Multibeam Echo Sounders (MBES) ○ Side Scan Sonars (SSS) ○ Sonar Data Processing • **Elements of Hydrographic Surveys** ○ SONAR survey requirements ○ Mission planning ○ Surveys in support of river crossings and engineering ○ Surveys in support of port management and coastal engineering ○ Ellipsoid referenced hydrographic surveys ○ Nautical charting and marine navigation ○ SONAL data applications ○ Data quality, errors, uncertainty ○ Mapping	**Competencies** • Describe and explain the principles and processes of hydrographic surveying • Describe and explain the concepts of sound wave propagation, acoustic system parameters, the physical properties of water and its impact on the speed of sound • Describe and explain hydro-acoustics concepts • Describe and explain tidal fundamentals • Describe and explain the ellipsoid-based water depth determination • Describe and explain the concepts of tides' generation, how they are measured and parameters affecting non-tidal water level variations • Describe and explain of sonar sensors, single beam and multibeam echo sounders and relevant calibration processes • Describe, explain side scan sonars technology, and its applications • Describe and explain ellipsoidally referenced hydrographic surveys **Learning Outcomes** • Apply the principles of horizontal and vertical positioning, datums, methods used for depth measurements, heave compensation systems and principles of motion sensors • Plan and manage hydrographic surveys and evaluate hydrographic data • Calculate water depths

C5: REMOTE SENSING

LEARNING OBJECTIVES

- **Establish the foundational knowledge in remote sensing required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes
Information from optical and range data: **-Photogrammetric Computer Vision**	●Used for 3D spatial data collection and 2/3D object reconstruction and mapping ●Used in UAV and mobile mapping applications	● **Camera calibration, measurement, and correction of image coordinates** ○ Coordinate transformations ○ Mathematical models for sensor and for sensor to object relationships collinearity, epipolar geometry, coplanarity, space resection, space intersection ● **Sensor poses estimation, photogrammetric bundle block adjustments, structure from motion, visual odometry** ● **Softcopy photogrammetry**	**Competencies** ● Describe and explain the use of optical and range data for 3D reconstructions and modelling ● Identify, describe, and apply the proper mathematical models ● Identify and apply the proper approach for sensor pose estimation ● Explain geometric and mathematical photogrammetric principles and the theory and procedures of photogrammetric orientations. ● Explain and apply the principles and mathematical models for DEM and orthoimage generation ● Explain and apply photogrammetric planning and identify control requirements. ● Identify and apply the use of photogrammetric principles for various applications ● Identify and explain the different camera calibration procedures **Learning Outcomes** ● Explain the concepts and uses of optical data for spatial data collection (3D position) and the 2/3D object reconstruction from optical and range measurements. ● Explain and apply the mathematical photogrammetric theory and procedures of photogrammetric triangulation (indirect, integrated sensor, direct, orientations). ● Examine the camera calibration parameters required for a photogrammetric project ● Calculate approximate coordinate precision from aerial imagery

C5: REMOTE SENSING

LEARNING OBJECTIVES

- **Establish the foundational knowledge in remote sensing required to be a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes

Mobile Mapping Systems
 	
Applications
	Used for 3D spatial data collection and 2/3D object reconstruction and mapping
	
	Used in UAV and mobile mapping applications
		• Mobile mapping, Direct georeferencing, Simultaneous Localization and Mapping (SLAM)
		  ○ 3D reconstruction from optical and range
		  ○ Image rectification
		  ○ DEM and orthoimage generation
		• Close range photogrammetry, Vanishing geometry
		• Mobile mapping systems
		• Navigation and mapping sensors
		• Reference coordinate systems and transformations of navigation and mapping sensors used for mobile mapping systems
		• Sensor co-registration including bore sighting and lever arm calibration
			Competencies
			
			• Describe and explain the mobile mapping systems and their role and uses in geomatics.
			• Describe and explain calibration of mobile mapping systems
			• Explain and apply the navigation and mapping sensors used on-board mobile platforms.
			• Identify and describe the coordinate systems and properly apply the coordinate transformations for mobile mapping applications.
			
			Learning Outcomes
			
			• Apply and analyze methods for platform and sensor localization (position and orientation)
			• Apply and analyze methods and computational algorithms for processing data captured by mobile platforms.
			• Design, plan and evaluate mobile mapping missions

C6: Geospatial Information Systems

C6: GEOSPATIAL INFORMATION SYSTEMS **LEARNING OBJECTIVES** ● **Establish the fundamental GIS knowledge required for decision making as a surveyor** ● **Support subsequent learning**			
Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes
FUNDAMENTALS OF GIS	Surveyors need to understand the geospatial perspective of the project/work they do and the use of GIS for their projects	● History, evolution and components of GIS ● Definition of and terminologies related to GIS ● Relation to other types of information systems ● Nature of geospatial data ● Geographic representation and data models (vector and raster data) ● Spatial referencing systems ● Map projections ● Base maps and map layers in GIS environment	**Competencies** ● Describe the concepts, principles, techniques, and applications that are fundamental to GIS ● Discuss how geospatial information systems differ from other information systems, technologies, and sciences **Learning Outcomes** ● Interpret requirements for GIS, data layers, base maps and explain the role of standardized data in geospatial information system development to support decision making for survey projects

COMPONENT 6: GEOSPATIAL INFORMATION SYSTEMS

LEARNING OBJECTIVES

- **Establish the fundamental GIS knowledge required for decision making as a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes
DATA VISUALIZATION AND MAP MAKING	Surveyors need to visually represent data collected from the field by creating colourful maps for clients and stakeholders	• Essentials of map design • Essentials of graphic communication • Cartographic principles • Cartographic elements • Visual variables • Map symbology • Map types • Map scale and generalization • Canadian spatial reference and map projection systems	**Competencies** • Discuss appropriate map design, elements, symbology • Explain spatial referencing systems to visualize spatial data • Sketch thematic maps and general reference maps • Practice measurement scales and their relationships to visual variables **Learning Outcomes** • Apply GIS software tools to create maps and visualizations that are fit-for-purpose and effectively convey the information they are intended to • Compare and organise data from multiple heterogeneous sources • Compare and analyse graphics (e.g., maps and other forms of geographic visualizations) to explain, interpret, and assess information

C6: GEOSPATIAL INFORMATION SYSTEMS

LEARNING OBJECTIVES

- **Establish the fundamental GIS knowledge required for decision making as a surveyor**
- **Support subsequent learning**

Key Principle	Motivation	Syllabus Items	Competencies/Learning Outcomes
SPATIAL DATABASES and MODELS	Important for surveyors to understand how and where spatial data is being stored and queried, as spatial databases are at the core of a GIS	• Concepts of spatial databases • Types of spatial database models • Concepts of database modeling • Concepts of Extract, Transform and Load (ETL) Processes • Data query and SQL • Concepts of data structures, spatial and aspatial Indexes • Applications of spatial databases in data warehousing	**Competencies** • Describe and explain spatial data type and data warehouse and use appropriate spatial data types and spatial data warehouse • Demonstrate spatial data integration • Demonstrate how databases are linked to GIS following either relational database model (e.g., traditional geo-relational model) or object-relational database model and design database queries. • Compare the GIS data modeling process by identifying and explaining the different levels of data abstraction (conceptual, logical, and physical), data models and their features **Learning Outcomes** • Design and evaluate geospatial data using DBMS with geospatial capabilities • Implement the concept of spatial data extraction, transformation, and load (ETL) • Analyse SQL-based GIS queries and formulate ETL scripts/processes

C6: GEOSPATIAL INFORMATION SYSTEMS LEARNING OBJECTIVES ● **Establish the fundamental GIS knowledge required for decision making as a surveyor** ● **Support subsequent learning**			
Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes
DATA ACQUISITION & MANIPULATION	Quality data needs to be acquired and manipulated to fit the purpose of survey projects	● Data acquisition ● Data precision and accuracy ● Data editing tools and techniques ● Data conversion tools and techniques ● Linear reference systems and dynamic segmentation ● Topological relationships and handling ● Metadata and data standards	**Competencies** ● Describe considerations for acquisition of quality field data ● Recognize and apply data editing and conversion techniques and data interpolation techniques ● Illustrate role of standards in data sharing ● Compare relevance and impact of data quality assessment **Learning Outcomes** ● Implement different GIS data acquisition approaches and data sources that require the knowledge of data quality, data fusion, data exchange, metadata management, and other issues such as data pricing, data access policies, privacy, security, and organizational influences. ● Examine and experiment appropriate tools and techniques to acquire and maintain high quality data and practice and apply appropriate data interpolation techniques

C6: GEOSPATIAL INFORMATION SYSTEMS

LEARNING OBJECTIVES

- **Establish the fundamental GIS knowledge required for decision making as a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes
GEOSPATIAL DATA ANALYSIS and ANALYTICAL MODELING	Data analysis and spatial modeling are critical for decision making	• GIS queries • Vector data analysis • Raster data analysis • Geoprocessing tools and techniques • Network analysis • Basic spatial statistical measures and analysis techniques • Types of spatial models • Analytical modeling • Big data analytics, non-structured data and NoSQL • Geospatial data mining methods • Dynamic geospatial data modeling • AI and deep learning	**Competencies** • Illustrate spatial thinking skills • Practice the specific problem solving and compare appropriate GIS analysis and modeling techniques to solve a specific problem • Operate GIS software tools to conduct spatial analysis **Learning Outcomes** • Demonstrate appropriate spatial analysis methods to support decision making • Experiment GIS analytical techniques and modeling to solve real-world spatial problems • Prepare data analysis and analytical modeling

C6: GEOSPATIAL INFORMATION SYSTEMS

LEARNING OBJECTIVES

- **Establish the fundamental GIS knowledge required for decision making as a surveyor**
  - **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes
Digital Elevation Modeling (DEM)	DEM is widely used to model and represent the 3rd dimension of the earth's surface	• Concepts, modeling, methods and techniques and data sources • Implementation and applications of digital terrain modeling (DTM) in geomatics • Mathematical approaches and techniques for terrain surface reconstruction, terrain analysis, structure, storage, processing and applications of DTM • Generation of elevation Grid from a set of elevation points • Generation of triangular irregular networks (TIN), Delauney triangulation and Voronoi diagrams • Generation of contour lines from TIN and elevation Grids • Global and local deterministic interpolation methods from point data; Kriging geo-statistical interpolation • DEM acquisition methods • Accuracy and quality control, terrain parameters, visualization and generalization, applications	**Competencies** • Describe the various data models used for DEM • Describe and discuss the various parameters for terrain analysis • Demonstrate and apply appropriate terrain surface interpolations • Demonstrate and implement various terrain related applications such as visualization, hydrology, and earthworks ones • Illustrate DEM concepts and principles and the terrain surface representation. **Learning Outcomes** • Interpret mathematical approaches and techniques for terrain surface interpolations and reconstruction. • Examine and interpret terrain/surface parameters, visualization, generalization, accuracy, and quality control • Compare and analyse data acquisition methods for DEM applications. • Design and evaluate DTM applications and terrain analysis.

C6: GEOSPATIAL INFORMATION SYSTEMS

LEARNING OBJECTIVES

- **Establish the fundamental GIS knowledge required for decision making as a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes
BUILDING INFORMATION MODELING (BIM)	BIM and GIS integration provide surveyors with enhanced digital surveying tools	• Concepts of BIM • BIM model progression and specifications • BIM standardization • BIM implementation procedures and tools • BIM and GIS integration	**Competencies** • Identify and recognize advantages and limitations of BIM for surveying projects and geospatial applications • Recognize and review the process of BIM and GIS integration • Describe concept of BIM • Demonstrate the understanding of BIM/GIS integration **Learning Outcomes** • Illustrate and demonstrate need for BIM and GIS integration based on project requirements

C6: GEOSPATIAL INFORMATION SYSTEMS

LEARNING OBJECTIVES

- **Establish the fundamental GIS knowledge required for decision making as a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes
WEB/CLOUD GIS AND MAPPING	WebGIS is empowering surveyors to access and upload live data in user friendly environment and enabling stakeholder participation in the decision-making process	• Concepts of Web/cloud and mobile GIS • Concepts and types of Web mapping services • Sources of on-line geospatial data and web mapping services • Mobile data collection tools • Applications of Web/cloud and mobile GIS (e.g., SDI) • Data catalogue services • Technical, organizational, social issues and policies and standards related to web and mobile GIS • Open Geospatial Consortium	**Competencies** • Identify and review, different types of web/cloud GIS and mapping • Recognize necessity of traditional desktop GIS in line with recent development of web/cloud GIS and mapping • Describe the new developments regarding web/cloud GIS and mapping services for better geospatial information dissemination, decision support and applications **Learning Outcomes** • Demonstrate and practice the use of desktop, web/cloud, and mobile applications appropriate for the purpose

C6: GEOSPATIAL INFORMATION SYSTEMS LEARNING OBJECTIVES ● Establish the fundamental GIS knowledge required for decision making as a surveyor ● Support subsequent learning			
Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes
GEOSPATIAL PROGRAMMING	Basic competence in programming is useful, if not critical, for geospatial data handling and analysis	● Basic concepts of geospatial programming ● Code libraries and APIs ● Geospatial programming languages and IDEs ● Customization of geospatial tools or applications ● Design, development and implementation of geospatial applications	**Competencies** ● Identify and describe the diversity and choice of programming languages and tools ● Describe the technology trends **Learning Outcomes** ● Demonstrate geospatial programming skills for data processing and spatial analysis. ● Practice and experiment appropriate programming languages, APIs and IDEs

C6: GEOSPATIAL INFORMATION SYSTEMS

LEARNING OBJECTIVES

- **Establish the fundamental GIS knowledge required for decision making as a surveyor**
- **Support subsequent learning**

Key Principles	Motivation	Syllabus Items	Competencies/Learning Outcomes
GIS PROJECT DESIGN AND IMPLEMENTATION	Well thought out GIS project design contributes to effective project execution	• Concepts GIS project design and implementation • User requirements • Principles and methods of software engineering as applied to GIS development • Strategies, plans and procedures for implementing an effective GIS system • Example applications	**Competencies** • Define and identify elements of GIS projects • Describe challenges with implementing GIS with special reference to: data, people, technology and application, including benefits and limitations • Review strategies, plans and procedures for implementing an effective GIS system **Learning Outcomes** • Review and use appropriate implementation procedures and GIS development strategies that follow the general principles of business modeling, software engineering, standards, and project management

C7: Law, Tenure, Boundaries, Cadastres and Planning

Key Principles	Motivation	Syllabus Items	Competency and Learning Outcomes

LAW, TENURE, BOUNDARIES & CADASTRAL SYSTEMS	Cadastral surveying upholds land tenure security	• Land tenure systems
		• Origins of land law
		• Philosophies of law
		• Canadian Legal System
		  ○ Common law and civil law (Quebec), concept of precedent in case law in common law versus civil law principles
		  ○ Legal Pluralism
		• Real Property Law
		• Land Registration
		  ○ Land transaction strategies
		  - Symbolic delivery and private conveyancing
		  - Registration of Deed and Registration of Title
		  ○ Indefeasible title, immediate versus deferred indefeasibility, quieting of title, critical conditions for an indefeasible title system to work.
		  ○ Chain of title, indefeasible title and mineral rights
		  ○ Provincial and territorial registries, Indian Land Registry, First Nation Lands Registry, Self-Government First Nation Land Registry, Metis Settlements Land Registry
		  ○ Indexes
		• Title Insurance
		  ○ Title Insurance and the unique situation in Canadian Torrens jurisdictions which also have title insurance.
		• Mineral rights and tenure
		  ○ Definition of a mineral and e*jusdem generis*
		• Types of Cadastral Systems
		  ○ Fiscal and juridical
		• Boundaries
		  ○ Types of Boundaries (e.g. frontiers, ambulatory, natural, general & fixed)
		  ○ Accretion, erosion and avulsion in relation to ambulatory boundaries, fixed boundaries and submerged boundaries
			Competencies
			• Be able to analyse land tenure systems and apply data modelling to the design of a database for land tenure records.
			• Be able to conduct field survey operations and prepare and present land survey records including: field notes, reports, calculations, diagrams and legal plans in a way that they adhere to good communication practice, the records can be examined by a person who is not involved in the survey, they can stand up to cross examination in court and the records may be considered as authentic evidence.
			• Be able to defend under cross examination: EDM and other instrument calibrations for cadastral surveys; validation measurements in the field to confirm calibration and validity of geodetic control; compare and explain the differences between expected precision based on error propagation and actual misclosure in control surveys; the application of corrections for projection scale factor, height above ellipsoid and arc-to-chord corrections in cadastral surveys.
			
			Learning Outcomes
			• Analyse different land tenure systems (e.g. allodial ownership, fee simple, condominium, communal, common property, open access, indigenous, customary) to inform debate on land policy, land law, legal pluralism, land information systems and boundary delineation.
			• Distinguish the difference between substantive aspects of land law and tenure and the legal procedures by which such rights are understood and administered in terms of type, spatial extent and perpetuation over time.
			• Develop an international perspective on the origins of law and case law from other countries which influence Canadian law and legal pluralism in Canada.

		○ Doubtful boundaries and their resolution, e.g. conventional lines, jurisdiction specific structures and processes to investigate and resolve boundary problems, bornage system in Quebec. ○ Boundaries and Land Management ○ Boundaries and Geospatial Information Systems –status of geometry versus topology in boundary re-establishment and spatial databases. ● Canada lands ● International and Offshore Boundaries, Law of the sea, UNCLOS and Oceans Act ○ Delimitation, delineation and demarcation ○ Exclusive economic zone, territorial sea, contiguous zone, high seas, baselines ○ Continental shelf, The Area ○ Conflict Management & Dispute Resolution in relation to international boundaries; International Court of Justice (ICJ), Permanent Court of Arbitration (PCA) and relevant cases. ● Cadastral Surveys and Land Survey Practice in Canadian Jurisdictions ○ Evidence and boundary retracement and re-establishment ○ Applying meridian convergence corrections and arc-to-chord corrections to cadastral surveys ○ Applying projection scale and height above ellipsoid corrections to cadastral surveys ○ Integrated surveys, coordinates, grid distances and ground distances ○ Plan checking and re-establishment calculations ○ Setting out cadastral calculations and communicating how data are compared (e.g. comparison sketches) to arrive at a legally defensible re-establishment solution for a doubtful boundary ○ Field Notes, Records, Calculations and Reports ○ Survey plans and land/property descriptions ○ Authentic evidence and weighting of evidence in the context of field notes, digital data, multi-	● Investigate and critically analyse relevant law cases, statutes, policies and academic articles on land tenure, boundary retracement, property rights and resource management, analyse and compare different authors' and judges' positions and communicate the contribution of these documents to land law and policy, survey law, cadastral survey practice and land tenure administration. ● Investigate and critically analyse relevant law cases and articles on indefeasibility of title. ● Analyse land titles and ownership of mineral rights, how they can be acquired and lost through the registration process. ● Describe and explain natural boundary principles and the common law principles of accretion, erosion and avulsion ● Identify, formulate, analyse, and provide alternative solutions to complex boundary problems and related problems to reach properly substantiated conclusions about the most probable positions of lost or doubtful boundary corners (re-establishment). ● Investigate and critically analyse relevant law cases, international and Canadian treaties, policy documents, Royal Commission reports, statutes and proclamations relating to Aboriginal tenure, rights and title ● Describe international boundaries, the law of the sea, maritime zones and seabed zones, the delimitation, delineation, and demarcation of international boundaries, and analyse international boundary conflicts ● Describe and explain boundary issues that may arise in a geospatial information system. E.g. concepts of topology and geometry and how a boundary line can be moved or not moved in a GIS. ● Analyse different philosophical orientations of ethics and formulate and present informed decisions on matters relating to ethics and professional land surveying practice and Aboriginal land claims

		media data, hearsay evidence, witness statements and clients' instructions ○ Expert witnesses ● Structure of the surveying profession in Canada and internationally ● Aboriginal Land Tenure and Law ○ Rights based vs. Utilitarian Concepts of Ethics and Law ○ Relevant policies, proclamations, accords, commissions, treaties, law cases and statutes. ● E.g. Royal Proclamation 1763, Charter of Rights and Freedoms 1982, White Paper of 1969, In All Fairness, Royal Commission on the Rights of Aboriginal Peoples, ILO Convention No. 169, UN Declaration on the Rights of Indigenous Peoples (2007) (UNDRIP), benchmark cases. ○ Self-government and the Indian Act ○ Land claims, comprehensive and specific claims ○ Interpretation of evidence in land claims, *sui generis* ● Land Tenure Databases and Data Modeling ● Introduction to ethics and professionalism: ○ Philosophical orientations including utilitarian versus rights-based approaches to ethics ○ Professional codes of ethics **Optional Syllabus Items** ● Theories of property and their relation to schools of ethics and Aboriginal land claims: ○ E.g. Locke, Mills, Bentham, Kant, Aristotle, Plato. ● Information pertaining to crown grants, reservations and exceptions ● Easements and Rights of Way ● Adverse Possession ● Descriptions ● Navigability considerations under Natural Boundaries ● Legal research ● Roads and Highways	

Key Principle	Motivation	Syllabus Items	Competency and Learning Outcomes

LAND USE PLANNING	Surveying is a critical discipline in land use planning	• The need for land use planning
		• Historical development of planning in ancient times and in Canada and current implications
		  ○ Nineteenth century and twentieth century planning philosophies
		  ○ Garden cities, utopians, city beautiful, city scientific, city efficiency, conservation movement, , parks movement, modernism, post-modern planning
		  ○ Sustainable planning, sustainable development goals (SDGs)
		  - Climate change, migration, urbanization
		  - National and international initiatives
		  - Triple Bottom Line, economic, social, environmental
		  ○ Legal and policy environments for international, national, regional, municipal and site-specific planning
		  ○ Legislation, Policy and Guidelines
		  - E.g. Regional, Metropolitan & Municipal Development Plans, Transportation Plans.
		  - Municipal by-laws, zoning, local development plans, structure plans, subdivision applications and appeals
		  - Provincial Legislation
		  - Regional Legislation and Plans
		  - City Design Standards
		  ○ Planning Process Theory
		  - Planning Design Strategies
		  - Rational comprehensive model
		  - Communicative model
		  - Critical pragmatic approach
		  - Goal ranking
		  - Cross Impact matrices
		  ○ Evaluating land use plans
		  ○ Transects
		  ○ New Urbanism, Smart Growth, Transit Oriented Development
		  ○ Participatory Planning
		  - Ladder of participation
			Competencies
			• Undertake a preliminary context assessment, environmental assessment and greenspace analysis a of a proposed development site
			• Design development layouts and communicate the designs and analyses using topographic surveys, topographic maps, layout plans, images, online mapping tools, and reports
			
			Learning Outcomes
			• Describe and explain the evolution of different settlement patterns and planning strategies in Canada
			• Describe the development of planning principles, structures and processes and analyze the tensions between different planning philosophies in Canada and internationally
			• Explain the legal and policy environments for international, national, regional, and municipal planning
			• Explain the purpose of regional plans, official community plans and zoning legislation and the role of the public and other stakeholders in planning processes
			• Develop and apply the design criteria necessary to undertake a land development design project - evaluate on-site constraints on development; analyze off-site constraints on development; locate and summarize local planning controls
			• Advocate for, or against, a proposed development based on environmental, social, and economic reasoning
			• Analyse the risks of a particular planning design

		- Participation structures and process in Canadian jurisdictions ○ Infrastructure Planning - Green infrastructure - Water bodies - Stormwater and sewerage - Transportation, including Public Transport & Emergency Services; national, provincial and municipal levels of transport - Utilities - Roads - Engineering services - Social Infrastructure ○ Aboriginal community planning ○ Subdivision Design - Topographic surveys, topographic maps, cartographic communication for subdivision layouts - Layout design - Financial Considerations, cash flow options releasing different parts of a project at different times, financial risk, net present value and return on investment. - Infrastructure and utility planning considerations - Legal analysis: encumbrances, caveats charges, existing zoning - Social and environmental analysis considerations - Connectivity: driving, public transport, cycling, walkability analysis to schools, city centre, recreation, shopping. - Road design, complete streets, public space, green space creation - Floodplain establishment	

		- International Great Lakes Datum (IGLD) 1985 (The Canadian Hydrographic Service (tides.gc.ca) ○ Risk analysis – chemical and natural hazards (fire, floods and tsunamis) ○ Location and flow factors in development projects	

Key Principle	Motivation	Syllabus Items	Competency and Learning Outcomes

ECONOMICS	Economics knowledge is important for a land surveyor especially in land use planning	• Micro and Macro-economics and their application to immovable property
		  ○ Supply and demand
		  ○ Capital
		  ○ Marginal contribution
		  ○ Law of diminishing returns
		  ○ Opportunity cost
		  ○ Elastic and inelastic supply and demand
		  ○ Economic rent
		  ○ Property markets
		  ○ Property investment
		• Time value of money
		• Financial and property valuation
		  ○ Cost of capital, Rate of Return
		  ○ Market value
		  ○ Income value
		  ○ Replacement value
		  ○ Depreciation
		• Return on investment
		• Categories of land use such as commercial, industrial, residential, agricultural, green space and valuation thereof
			Competencies
			• Perform net present value and rate of return calculations on different cash flow scenarios for potential development projects.
			Apply time value of money concepts to income value methods of property valuation
			
			Learning Outcomes
			
			• Explain the concepts of supply and demand and elasticity and inelasticity of supply and demand in property markets
			• Explain the different methods of valuing property and other assets (e.g. minerals, agricultural output)
			• Explain the cost-benefit approach to project evaluation and the strengths and weaknesses of the methodology
			• Explain the concept of triple bottom line and how planners and politicians might mitigate the tensions between these criteria in a municipal plan
			• Describe how an investor might arrive at a rate of return/cost of capital when evaluating whether a particular project is worth financing
			• Explain why long term loans are likely to have a higher interest rate than short term loans.

C8: Professional Practice

Key Principles	Motivation	Syllabus Items	Competency/Learning Outcomes

BUSINESS LAW & PRACTICES	Surveyors are often owners or partners of businesses, employers, including supervisors require an understanding of employment legislation and regulations
	
	Surveyors often enter into contracts or bids for projects in the private or public sector
	
	Surveyors may be retained as an Expert Witness in court proceedings
		• Types of business entities and arrangements–pros and cons of each
		• Duties, responsibilities, and liabilities
		  ○ Directors of a corporation
		  ○ Shareholders of a corporation
		• Types of insurance required by a surveying business
		  ○ Professional liability (Errors and Omissions (E&O))
		  ○ General liability
		  ○ Commercial, theft, fire, vehicle, equipment
		• Contract Law
		  ○ Elements of a contract
		  ○ Differences between oral and written
		  ○ Discharge of contract
		  ○ Conflict of interest
		  ○ Copyright
		  ○ Confidentiality
		  ○ Non-compete agreements,
		  ○ Non-disclosure agreements
		• Litigation and liability
		  ○ Employer statutory obligations in Canada
		  ○ Elements of a negligence action
		  ○ Liability in torts
		  ○ Due diligence
		• Expert Witness
		• Surveyor's Opinion
		•
			Competencies
			
			• Develop an understanding of the various common business structures and the duties, responsibilities and liabilities associated with each
			• Think through what type of business entity is right for me or this project
			• Understand statutory obligations for employers in Canada and common types of litigation and liabilities associated with practicing surveying
			• Understand Professional liability insurance in Canada
			  ○ Communication issues
			  ○ Contractual issues
			  ○ Computations issues
			• Understand Builder's lien
			• Understand obligations and responsibilities in a contract
			• Understand the role of the Expert Witness as a "friend of the court" and the ability to give an opinion
			
			Learning outcomes
			
			• Demonstrate an understanding of the types and purposes of insurance, business entities and project delivery arrangements
			• Write an effective "contract for services"
			• Analyze potential loss scenarios and determine types of insurance involved
			• Identify the critical components for surveying services and why they are important to the surveyor

Key Principle	Motivation	Syllabus Items	Competency/Learning Outcomes

MANAGEMENT & BUSINESS SKILLS	Surveyors need to understand management and business skills to effectively interact with different stakeholders and to optimize the profitability of their business	• Business plans
		  ○ Marketing
		  ○ Strategic Planning
		  ○ Succession Planning
		  ○ Financial Planning
		  ○ Organizational Structure
		• Business Financing and Financials
		  ○ Capitalization
		  ○ Loans and Mortgages
		  ○ Financial Statements, Balance sheet and income statement
		  ○ Accounts Receivable and Accounts Payable
		  ○ Assignment of book debts
		  ○ Salary Markups and Multipliers
		  ○ Capital Costs and Operating Costs
		  ○ Project Cost Estimates
		  ○ Owning vs. Leasing
		  ○ Assets and Liabilities
		  ○ Depreciation
		  ○ Retainers
		  ○ Goodwill
		• Business Valuation for an Acquisition or Sale
		• Bonding and its uses
		• Basic management skills
		  ○ Human Resources (HR)
		  ○ Social Responsibility
		  ○ Negotiation
		• Business codes of conduct
			Competencies
			
			• Understand how a typical business is financed and how it is financially operated
			• Negotiation skills
			• Use business and management principles to lead people and manage business activities effectively
			• Pursuing payment of an account through a Bond
			• Identify the current condition of a business and the plans required to achieve the future goals
			• Understand that an owner must be able to measure the fitness of a business before setting goals
			
			Learning outcomes
			
			• Develop a basic business plan
			• Demonstrate ability to read and understand financial documents as it relates to the surveying profession
			• Apply knowledge of basic management skills to effectively implement appropriate HR and other management practices

Key Principles	Motivation	Syllabus Items	Competency/Learning Outcomes
HEALTH and SAFETY	Surveyors need to be aware of legislated requirements as employers and employees, protect the public Surveyors need to actively demonstrate a safety culture: "We want everyone to go home safe every day"	• Health and Safety (OH&S) legislation–general & injury reporting • Workplace inspections • Policy statement • OH&S program–general elements • Hazard Control • Emergency planning • Site specific Safety • Violence & harassment in the workplace https://www.ccohs.ca/topics/legislation/programs/	**Competencies** • Use knowledge of OHS legislation to develop and implement projects safely • Use knowledge of OHS to report incidents appropriately and effectively • Use knowledge of rights and responsibilities of employees to report inappropriate behaviour (i.e. violence, harassment, safety. . .) • Knowledge of OHS legislation for inclusion when project planning and submitting contracts/bids **Learning outcomes** • Describe general components of safety policies or programs • Calmly respond to critical incidents • Conduct hazard identification and implement mitigation measures • Demonstrate safe behaviour in all activities • Report and document hazardous activities

Key Principles	Motivation	Syllabus Items	Competency/Learning Outcomes

PROFESSIONALISM AND ETHICS	Professional surveyors adhere to and uphold professional standards to protect the public
	
	and
	
	Professional Associations protect the public interest by upholding standards of competencies and conduct by educating and/or
	
	disciplining members that do not adhere to the standards
		• Regulatory, advocacy and other associations
		• Licensure versus certification
		• Self-governed Professional associations
		  ○ Reason for existence
		  ○ Structure
		  ○ Main attributes
		  ○ Roles
		  ○ Responsibilities
		• Standards of professional practice
		  ○ Government standards
		  ○ Professional association standards
		• Professional ethics and interaction
		  ○ Utilitarian versus rights-based approaches to ethics
		  ○ Major components
		  ○ Types of code of ethics
		  ○ Client Confidentiality vs Public Protection
		  ○ Conflict of Interest
		• Professional Misconduct
		• Incompetence
		• Complaint process
		• Discipline process
		• Continuing education
		• Labour mobility agreements
		• Examine and report on the work of another surveyor
			Competencies
			
			• Understand responsibilities and obligations for ensuring for Public protection
			• Understand the benefits of participation in their Professional Association
			• Understand the role ethics plays when carrying out professional obligations inherent with a license to practice
			• Understand the importance of standards of practice
			
			Learning outcomes
			
			• Demonstrate maintenance of competencies required for professional surveying practice.

Key Principles	Motivation	Syllabus Items	Competency/Learning Outcomes

PROJECT MANAGEMENT	Surveyors need to understand project management so they can safely deliver quality projects on time and on budget	• Introduction to Project management areas:
		  ○ Integration management
		  ○ Scope management
		  ○ Time management
		  ○ Cost management
		  ○ Risk management
		  ○ Human resources management
		  ○ Procurement management
		  ○ Quality management
		  ○ Stakeholder management
		  ○ Communication management
			Competencies
			
			• Understand responsibilities related to the protection of the public and the environment
			• Understand how a land surveyor's work impacts the environment–i.e. considers the environment through their professional opinion
			• Develop effective report writing skills, record keeping and documentation throughout the project
			• Rationalize the potential profit versus the peril of cost overruns
			• Understand the difference between QC and QA
			
			Learning outcomes
			
			• Deliver projects that meet objectives
			• Delivery of quality projects safely, on time and on budget
			• Apply knowledge of the difference between quality control and quality assurance and how each is applied in a survey practice

Key Principles	Motivation	Syllabus Items	Competency/Learning Outcomes

COMMUNICATIONS	Surveyors need to express themselves with multiple stakeholders to conduct their work and achieve successful outcomes	• Stakeholder Identification
		• Business, Professional and Technical Communication skills
		  ○ Written
		  ○ Oral
		  ○ Visual (Graphical)
		  ○ Electronic
		  ○ Technical Reports
		• Presentation Skills
		• Leading meetings
		• Active listening skills
			Competencies
			
			• Utilize effective written communication
			• Utilize effective oral communication
			• Utilize effective electronic communication
			• Utilize active listening skills
			
			Learning outcomes
			
			• Employ clear, concise and profession-specific language
			• Employ appropriate formatting, grammar and spelling
			• Employ effective questioning techniques
			• Demonstrate a working knowledge of current technologies
			• Maintain security of electronic communication.
			• Describe the use and characteristics of active listening
			• Clarify contradictions
			• Prepare and present technical material to an audience in a clear, concise and effective way
			• Prepare a written report
			• Effectively communicate instructions to office/field

Key Principles	Motivation	Syllabus Items	Competency/Learning Outcomes

DIVERSITY, EQUITY & INCLUSION	Surveyors need to recognize the diverse needs of different stakeholders	• Stakeholder identification and awareness
		• Understand importance of DEI in conducting work
		• Unconscious Bias
		• Canadian Human Rights Act
		• Equitable access to opportunities
		• Facilitate equitable and inclusive participation in all activities
		• Remove or mitigate barriers
		  ○ Discrimination
		  ○ Gender based exclusion
		  ○ Racism
		  ○ Cultural differences
		  ○ Age
		  ○ Socio-economic standing
			Competencies
			
			• Examine and counter own biases about diverse people and perspectives
			• Understand how common biases can affect outcomes
			• Adjust behaviour to accommodate different perspectives
			
			Learning outcomes
			
			• Explain why DEI is important to the surveying profession
			• Recognize and interrupt bias
			• Apply knowledge and self-awareness to interact effectively with diverse team members, peers, supervisors and other stakeholders
			• Demonstrate active listening to account for different perspectives and to create inclusive environments

APPENDIX H

AERC Policy – Supervision of Articles

Status:	Approved	Version #	1
Date Approved:	2025-04-15	AERC Motion	25-50
Date Revised:		AERC Motion	

Background

The statutory requirements for the supervision or a term of articles are specified in Section

(6) A term of articles shall be under the direction of,

(a) if the applicant is applying for a licence, a member who became a licensed member at least three years before the beginning of the term; or

(b) if the applicant is applying for a certificate of registration, a member who has held a certificate of registration for at least three years before the beginning of the term or a person who in the opinion of the Academic and Experience Requirements Committee is competent to provide and direct the approved professional experience. R.R.O. 1990, Reg. 1026, s. 23 (6).

23(6) of Regulation 1026 of the Surveyors Act. This section reads as follows:

It would be beneficial for the Association and the Profession to further specify the required qualifications for a Supervising Surveyor.

Policy

AERC will require all future Supervising Surveyors and Supervising Professionals to be in good standing (does not have a complaint that was referred to Discipline, currently in a Discipline Proceeding, subject to a Discipline Committee or Complaints Committee order, etc.).

AERC will also require Cadastral Supervising Surveyors to be Full License holders. Certificate of Registration Holders and Limited License Members will not be permitted to act as Supervising Surveyors or Supervising Professionals for cadastral applicants.

APPENDIX I

AERC Policy – Articling Re-Application

Status:	Approved	Version #:	1
Date Approved:	January 21-22, 2025	AERC Motion	25-XX
Date Revised:		AERC Motion	

Background

There are several sets of circumstances that may cause an articling student's articles to be cancelled for the purposes of the Academic and Experience Requirements Committee which include the following:

A. Termination of Articling Contract – articles will be cancelled after 3 months of accumulated time since the student was last under the contractual supervision of the articling surveyor and a new articling contract has not been signed with a new eligible articling surveyor. See Articling Student Handbook Section A:6 Assignment of Articles.

B. Period of Articles has Expired – articles will be cancelled if all requirements are not met within the prescribed time period of 4 years (one additional year may be granted for parental leave consideration). See Regulation 1026 Section 23(8)(8.2).

C. Period of Re-Examination has Expired – an articling student may make up to 3 exam attempts within 3 years after the day of the original exam. See Regulation 1026 24(3).

D. Three unsuccessful Professional Exam Attempts – See AERC Policy 5.3

E. An articling student may also request their articles be cancelled.

AERC will cancel a student's articles, and they may not re-apply for a period of one year in the case of circumstances B, C, and D above.

This policy is intended to provide guidance on whether additional articling time, a certificate of completion, exam writing, or any combination thereof are required under specific circumstances.

Policy

Any re-application will require a new academic evaluation to be completed (if the previous one has expired) Any request to consider previous articling experience of any amount of time (not limited to six months) will be considered. A new certificate of completion is required in all cases. AERC will assess whether credit may be granted for examinations previously completed during a prior articling period. Such credit will be determined based on the relevance and currency of the examination content relative to current standards, practices, and legislation. See O. Reg. 1026 sec 23 (8.2).

In all cases the AERC may make discretionary decisions based on extenuating circumstances. These circumstances may include but not be limited to situations where students have continued working in the capacity of an articling student throughout the time of cancellation and demonstrated a commitment to gaining substantial knowledge and experience in the absence of an articling contract.