GGE

GEODESY AND GEOMATICS ENGINEERING

The courses presently offered in the Geomatics Engineering Program by the Department of Geodesy and Geomatics Engineering are described below.

The first digit of the identification number indicates the level of the course. A “5” indicates an elective course, normally done in the final year.

The second digit normally indicates the subject area as follows:

0  measurement, positioning and navigation
1  applied analysis
2  geodesy
3  imaging and mapping
4  information management, modelling and visualization
5  land administration
6  synthesis and design
7  technical communication, complementary studies
8  service course for other disciplines
9  general [geodesy or geomatics or both]

The third digit carries the course sequence identification integer where "0" refers to the first course, "1" to the second course, and so on.

For list of core courses and technical elective courses, see Section G.

Note: See beginning of Section H for abbreviations, course numbers and coding.

GGE 1001  Introduction to Geodesy and Geomatics  5 ch (3C 3L)
Introductory geodesy and geomatics. Measuring geometry (surveying, hydrography, satellite positioning, navigation, photogrammetry and remote sensing, ocean mapping). Understanding measurements (introductory uncertainty & estimation theory). Managing geographic information. Applications of geomatics techniques, including creation of topographic plans from electronic total stations.

GGE 1803  Practicum for Civil Engineers  2 ch
Two weeks of practical exercises following spring examinations. Involves optical distance measurement; trigonometric heighting; tapping; balancing angles, height differences, traverses; horizontal circular curves; vertical curves; area & volume computations; stream gauging; elementary photogrammetry. Prerequisite: GGE 1001 or equivalent.

GGE 2012  Advanced Surveying  4 ch (2C 3L)
Barometric and trigonometric heighting. Precise levelling. Mechanical distance measurements. Electronic angle and distance measurement, total stations, and reflectorless EDM. Coordinate transformations and positioning by trigonometric sections. Route and construction surveys. Geodetic control surveys: from triangulation to GPS. Digital terrain models. Contouring. Practical use of GPS. Introduction to the design of surveys and specifications. Prerequisites: GGE 1001, STAT 2593.
GGE 2013  Advanced Surveying Practicum  4 ch
Two weeks of practical exercises following spring examinations. Prerequisites: GGE 2012, STAT 2593.

GGE 2413  Mapping Concepts and Technology  5 ch (3C 3L)
Introduction to computer-based systems and processes for creating, managing, analyzing and visualizing spatial information. Introduction to geographic information systems (GIS), spatial data structures and 2-dimensional spatial transformations. Comparative overview of alternative spatial data collection technologies. Systems-based approaches to desktop mapping, cartographic production and map analysis. Basic properties and applications of common map projections. Prerequisites: CS 1003 or 1073, MATH 1503 or equivalent introduction to matrices and systems of linear equations.

GGE 2501  Land Administration I  4 ch (3C 3L)
Introduction to the principles of cadastral systems and survey law with a focus on Canadian jurisdictions. An extensive reading list supplements the lecture material. Students will be required to conduct a title search, write property descriptions, review legal cases, and complete other laboratory assignments demonstrating the practical aspects of managing cadastral survey systems.

GGE 3022  Survey Design and Analysis  4 ch (2C 3L)

GGE 3023  Surveying Design Practicum  4 ch
Two weeks of practical exercises following spring examinations. Prerequisite: GGE 3022.

GGE 3042  Space Geodesy  5 ch (3C 3L)
Principles of space geodesy. The celestial sphere, its coordinate systems, and variations in coordinate systems. Star observations. Time keeping. Satellite based positioning systems, especially the Navstar Global Positioning System (GPS) including observations, development of mathematical models, static and dynamic positioning, error analysis, software structure, and processing considerations. Prerequisites: MATH 1503, MATH 2513. Corequisite: GGE 3202.

GGE 3111  Introduction to Adjustment Calculus  5 ch (3C 3L)
Calculus of variations; quadratic forms; least-squares principles; least-squares method, weight matrix, variance factor; parametric, condition and combined adjustment. Prerequisites: MATH 1503, MATH 2513, STAT 2593.

GGE 3122  Advanced Adjustment Calculus  5 ch (3C 3L)
Hilbert space approach to adjustment, uni- and multivariate statistical testing; approximation, prediction, filtering; constraint functions; weighted parameters. Prerequisites: GGE 3111, MATH 2513; Co-requisite: CS 3113.

GGE 3202  Geodesy I  4 ch (2C 3L)
Introduction to the subject of geodesy; kinematics, gravity field, and size and shape of the Earth; temporal deformations of the Earth. Geodetic control in Canada. History of geodesy. Geodetic heighting. Prerequisites: ENGG 1081, PHYS 1082, MATH 1503, 2513. Co-requisite: MATH 3543.

GGE 3342  Imaging and Mapping I  5 ch (3C 3L)
Overview and physical basis of remote sensing. Space- and air-borne sensor systems, active and passive sensors. Fundamental geometry of photogrammetry. Image statistics. Rectification of digital imagery. Image enhancement, spectral and spatial filtering. Multi-spectral transformations. Thematic information extraction, classification and accuracy assessment, change detection. Credit will be given for only one of GGE 3342 or GGE 5342. Prerequisite: GGE 2413 or permission of instructor.

GGE 3353  Imaging and Mapping II  5 ch (3C 3L)
Introduction to hydrography: geomatics aspects, trends and prospects, role in offshore management. Depth
determination: seabed and seawater properties, non-acoustic methods, underwater acoustics, vertical and oblique incidence methods, bathymetric and imaging methods. Prerequisite: MATH 3543, GGE 3342.

GGE 4022  Precision Surveying  4 ch (2C 3L)
Measurements, processing, and analysis in densification surveys. Control surveys for photogrammetry and construction. Introduction to mining and tunnelling surveys, deformation measurements and analysis, and industrial metrology. Prerequisite(s): GGE 3022, GGE 3023, GGE 3122.

GGE 4211  Geodesy II  5 ch (3C 3L)
Terrestrial, celestial and orbital coordinate systems; coordinate transformations; positioning in 3 dimensions, on the ellipsoid and on a conformal mapping plane. Height systems. Prerequisites: GGE 3202, MATH 3543.

GGE 4313  Imaging and Mapping III  5 ch (3C 3L)

GGE 4403  Geographic Information Systems  4 ch (2C 3L)
Applications of hardware and software components of geographical information systems (GIS). GIS functions and architecture. Characteristics of GIS data structures and database management systems. Introduction to spatial modelling and analysis. GIS data integration and standards. Prerequisites: GGE 2413 or permission of instructor.

GGE 4512  Land Administration II  3 ch (2C 1L)
Introduction to modern issues in land tenure and administration from Canadian and international perspectives. Includes the role of property systems in land management, aboriginal rights to land and natural resources, parcel-based land information systems, comparative analysis of land administration systems, coastal zone management, law of the sea, and delimitation of maritime boundaries. Prerequisite: GGE 2501 or permission of instructor.

GGE 4541  Geomatics Engineering Economics and Management  3 ch (2C 2L)
Outline of government and professional organizations involved in the management of geomatics in Canada: multi-purpose geomatics programs; the time value of money, depreciation, inflation; national and regional benefit/cost geomatics case studies; decision making in the public sector. Financial statements; break even analysis, decision making in the private sector. Prerequisite: ECON 1073, completion of at least 135 credit hours.

GGE 4700  Design Project and Report  6 ch (2C 2L)
A full year course (fall term then winter term) involving the design and implementation of a geomatics activity or project and a reporting on the results or outcome, all under the direct supervision of a faculty member or equivalent in industry. Lecture topics include: engineering economics and business management issues specific to geomatics; financial decision making in geomatics. Must be done in the student’s final year of the programme.

GGE 5013  Oceanography for Hydrographers  2 ch (3C 1L)
Descriptive and theoretical introduction to physical oceanography, focusing on the coastal zone and the continental shelf. Components of physical oceanography that affect the accuracy and operational conduct of hydrographic surveying. Detailed studies of the controls on sound speed structure (seawater properties, propagation and refraction). Half term course (6 weeks).

GGE 5023  Tides and Water Levels  2 ch (3C 1L)
Detailed studies of the controls on surface water level (tides, waves and swell, vertical reference surfaces). Constituent extraction from tidal observations and prediction of tides. Discrete and continuous tidal zoning,
including an introduction to coastal hydrodynamic models. Half term course [6 weeks].

GGE 5033  Marine Geology for Hydrographers  2 ch (3C 1L)
Descriptive marine geology including all ocean depths, but focusing on the coastal zone and continental shelf. Components of surficial sedimentology that affect the accuracy and operational conduct of hydrographic surveying. Detailed studies of the controls on seafloor processes (deposition and erosion) and bottom backscatter strength (sonar performance, geomorphology, sediment classification). Half term course [6 weeks].

GGE 5041  Engineering Surveying  4 ch (2C 3L)
Design and analysis of deformation surveys. Geotechnical measurements of tilt, strain, stress, etc. Special surveying methods and instrumentation of high precision. Application of lasers. Prerequisites: GGE 4022, GGE 3122.

GGE 5042  Kinematic Positioning  5 ch (3C 3L)
Performance requirements, mathematical models, observation methods, processing strategies, uncertainties and other characteristics associated with moving marine, land airborne, and space vehicle positioning, orientation and attitude applications, using autonomous, terrestrial, satellite, and acoustic methods. Prerequisites: GGE 3042, GGE 3122, GGE 3353, GGE 4211.

GGE 5043  Marine Geophysics for Hydrographers  2 ch (3C 1L)
Descriptive and introductory-theoretical marine geophysics including single-channel, 2D multi-channel and 3D multi channel reflection seismic surveying. Marine refraction seismology, marine magnetic surveys (focus on target detection) and marine gravity surveys. Half term course [6 weeks].

GGE 5061  Mining Surveying  4 ch (2C 3L)

GGE 5072  Hydrographic Data Management  3 ch (2C 3*L)
Principles and use of hydrographic data management tools which acquire, clean, store, retrieve, select, interpolate, determine uncertainty, colour-code, and visualize individual and aggregated high density observed depth data points. Hydrographic data layering, analysis, artificial illumination, texturing, and animation. Visualization requirements and standards for safety of navigation. Prerequisites: GGE 3353, GGE 4403.

GGE 5083  Hydrographic Surveying Operations  3 ch
Planning, executing and appropriately presenting the results from a hydrographic survey. Seamanship and piloting. Survey case studies. Six to eight weeks on a hydrographic survey vessel after the spring examinations or before the next fall term. Enrollment is limited to the capacity of the vessel. Students will be responsible for paying their own travel and accommodations for the field work. Prerequisites: GGE 3353, GGE 5013, GGE 5072.

GGE 5093  Industrial Metrology  4 ch (2C 3L)
Spatial measurements of high precision for experiment lay-out and industrial setting-out and quality assurance. Prerequisite: GGE 4022.

GGE 5131  Special Studies in Adjustments  4 ch (3C 3*L)
Hilbert space techniques; sequential techniques; digital filtering; interpolation and approximation; large system techniques. Prerequisites: GGE 3122.

GGE 5222  Gravity Field and Geodetic Networks  4 ch (2C 3L)
Prerequisites: GGE 3022, 3122, 4211.

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites</th>
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<tbody>
<tr>
<td>GGE 5242</td>
<td>Special Studies in Geodesy</td>
<td>4 ch (3C 3*L)</td>
<td>GGE 3202, GGE 4211.</td>
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<tr>
<td></td>
<td>Review of coordinate systems. Orbit dynamics. GPS for high precision positioning and navigation. Major practical lab in GPS positioning.</td>
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<tr>
<td>GGE 5322</td>
<td>Digital Image Processing</td>
<td>4 ch (3C 3*L)</td>
<td>GGE 3342 and experience in programming, preferably in C/C++.</td>
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<td>Image data formats; software code for input and output images; writing, compiling and running software code; advanced image processing and computer vision algorithms and software programming; includes advanced edge detection, mathematical morphology, image segmentation, texture, skeletonization, image restoration, wavelets, image matching, fuzzy logic.</td>
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<tr>
<td>GGE 5332</td>
<td>Special Studies in Photogrammetry</td>
<td>4 ch (3C 3*L)</td>
<td>GGE 3122, GGE 3202, GGE 3023, GGE 3122, GGE 4211, GGE 4512.</td>
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<td></td>
<td>An in-depth treatment of various topic areas, such as terrestrial photogrammetry, orthophotography and rectification, cameras, instrumentation and auxiliary aids.</td>
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<tr>
<td>GGE 5413</td>
<td>Special Studies in Digital Mapping</td>
<td>4 ch (2C 3L)</td>
<td>GGE 4403.</td>
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<td></td>
<td>An in-depth treatment of topics in digital mapping such as software engineering, computational geometry, and three-dimensional data structures.</td>
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<td>GGE 5521</td>
<td>Survey Law</td>
<td>4 ch (3C 3*L)</td>
<td>GGE 2501, GGE 3022, GGE 3023, GGE 3122, GGE 4211, GGE 4512.</td>
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<td>GGE 5532</td>
<td>Land Economy and Administration</td>
<td>3 ch (3C)</td>
<td>GGE 4512.</td>
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<td></td>
<td>Introduces land management and administration from economic and institutional perspectives. Evolving concepts of property and land tenure systems. Role of property institutions in land management. Economic principles in the valuation, allocation, development, and conservation of land resources. Land administration and land information systems. Special issues such as coastal zone management, environmental management, aboriginal tenure, and land reform.</td>
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<td>GGE 5543</td>
<td>Marine Policy, Law, and Administration</td>
<td>3 ch (3S)</td>
<td>GGE 4512.</td>
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<td>Coastal and marine [offshore] legal issues and how they relate to the framework of policy and administration. Focuses primarily on Canadian legal and policy regime, drawing on international law and practice where appropriate. Law of the sea and delimitation of zones and boundaries; Canadian coastal and offshore jurisdictional and administrative issues; coastline delimitation for various purposes; legal issues related to hydrographic surveys, hydrographic data, and marine accidents. Legal principles involved when designing and planning various marine surveys.</td>
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<td>GGE 5703</td>
<td>Exploration and Surveying in Literature and the Arts</td>
<td>3 ch (1C 3S)</td>
<td>GGE 4512.</td>
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<td>A complementary studies elective examining the place and portrayal of exploration and explorers and surveying and surveyors in contemporary and historical literature and, also, in the arts, especially in print media, painting, photography, and the cinema. Open to geomatics engineering students in their final year of their programme.</td>
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<td>GGE 5813</td>
<td>Urban Planning for Geomatics</td>
<td>3 ch (3C)</td>
<td>GGE 4512.</td>
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<td></td>
<td>Introduction to city and regional planning. The evolution of cities, discussion of planning in municipal administration, principles of land use, urban transportation, municipal services, subdivision design, comprehensive planning, master plans, programs, planning studies, and the administration and enforcement of planning regulations. Restricted to students with at least 90 ch completed.</td>
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<td>GGE 5842</td>
<td>Site Planning for Geomatics</td>
<td>3 ch (2C 3L)</td>
<td>GGE 4512.</td>
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To better appreciate the comprehensive nature of site analysis and the physical, social and environmental impacts of engineering works on a site and its surroundings. To incorporate site characteristics to enhance a project in terms of costs, appearance, and energy efficiency. This course will be limited to a maximum of 18 students. Restricted to students with at least 90 ch completed. Prerequisite: GGE 5813 or CE 5313.

**GGE 5901 Special Studies in Geomatics I**
1 ch (1T 1L)
Directed study in an approved topic in geomatics. Supervision by a faculty member. Normally done in a student’s final term. Credit will be given for only one of GGE 5901, 5902, or 5903.

**GGE 5902 Special Studies in Geomatics II**
2 ch (1T 3L)
Directed study in an approved topic in geomatics. Supervision by a faculty member. Normally done in a student’s final term. Credit will be given for only one of GGE 5901, 5902, or 5903.

**GGE 5903 Special Studies in Geomatics III**
3 ch (1T 5L)
Directed study in an approved topic in geomatics. Supervision by a faculty member. Normally done in a student’s final term. Credit will be given for only one of GGE 5901, 5902, or 5903.