Course Outline

COURSE INFORMATION	
Title	**Geodetic Concepts**
Rubric and Number	LE/ESSE 3610 3.0
Term	Fall
Year	2016
Lecture time and location	Tuesdays and Thursdays 10:00-11:30 (10:00am-11:30am) LSB 107
Lab time and location	Mondays, 19.00-20.30 (7:00pm-8:30pm) PSE 020

COURSE DETAILS

Course description

Organization

Since every individual responds to different stimuli in his / her learning process, the presentation of material will be done in a variety of ways. All methods will require work on your part to be effective. We will take a participative approach to learning, which means that we will learn **with** each other and **from** each other. **Therefore, we are all responsible for being prepared for class:**

- Each lecture requires that you prepare by reviewing the upcoming lecture agenda and material provided.
- Each lecture will normally commence with a brief review of the concepts treated in the previous session.
- New subject(s) will be treated after the review, according to the tentative lecture schedule provided in this document. **Participation** is an essential element of learning. It will be **encouraged** and **assessed**.
- Examples will be given, where applicable, to understand the concepts.
- Cell phones, music players, etc. must be turned off during the lecture.

Labs and Project

- Assignments are due at the beginning of the lab period stated in the handout. The assignments will comprise derivations, calculations, programming, methodology development and assessment, computer programming, and use of software applications. Emphasis will be placed on the accuracy and presentation (legibility and neatness) of the reports.
- Laboratory reports serve also as a means of developing technical writing skills. Your reports will also be assessed for clarity, structure, grammar and other elements such as presentation and neatness. Illegible reports are unacceptable and may not be evaluated.
- *Participation is mandatory.*

Feedback on Progress

Feedback on your progress will be provided in four different ways:

- Each lecture should give you a fair idea of how well you have understood the material. This is the MOST important and timely form of feedback.
- Assignments (individual and group). You will be asked to solve specific computational problems, draw maps, use software, design and develop computer code, and write reports. They will help you assimilate and

consolidate material presented in lectures. Your participation is essential.
- Mid-term test.

Announcements

Announcements and information related to the course, such as special lectures, class cancellations, change of due dates, etc. will be made during lecture and laboratory sessions, via e-mail, and on the course Moodle site.

Learning Objectives

Purpose

The primary purpose of this course is to learn, understand and be able to apply the fundamental concepts of Geodesy, the scientific framework of Geomatics.

Course learning outcomes

To understand the fundamental concepts of Geodesy, the scientific framework of Geomatics.

1.1 To explain what geodesy is
1.2 To describe the main tasks of geodesy
1.3 To define the fundamental problems that geodesy solves, so as to understand the fundamental importance of this science for positioning
1.4 To explain the concept of point positioning, and the underlying ideas of coordinate systems for positioning

To develop knowledge and understanding of the fundamentals of geodetic astronomy, and to apply them in practice

2.1 To explain the fundamental aspects of geodetic astronomy such as the celestial sphere, coordinate system designations, and physical effects defined in these designations, in order to determine position with respect to celestial objects
2.2 To physically and mathematically define all relevant celestial and terrestrial coordinate sytems, explain their utility, and mathematically transform data from one system to another with respect to celestial objects

To develop knowledge and understanding of the different coordinate systems, including time systems, and the transformations among them, and to practically perform the ralevent computations

3.1 To be able to define the different categories of time scales used in geodesy, the specific time scales within each category
3.2 To be able to define the modern conventioal celestial and terrestrial reference systems
3.3 To be able to define parallax, aberration, proper motion, atmospheric refraction and describe the effect of each on dynamically-defined coordinate systems
3.4 To perform the transformation between kinematic systems

To become familiar with the IERS international standards for high accuracy spatial positioning

To become familiar with the different geodetic positioning techniques, their concepts, capabilities and accuracy.

4.1 To describe the horizontal positioning techniques (principle and measurements)
4.2 To describe the vertical positioning techniques (principle and measurements)
4.3 To describe the 3D positioning techniques, specifcally the fundamental elments for satellite positioning (princinple and measurements)

To extend knowledge of fundamental reference coordinate systems to modern reference systems, reference frames and datums, and to work with them in practice

5.1 To explain the geodetic datums and the datums used in Canada and

	internationally (e.g. WGS84, NAD83, CVGD27, CVGD2013 etc) 5.2 To be able to transform between astronomical and geodetic positions 5.3 To be able to transform between conventional terrestrial and geodetic systems 5.4 To be able to transform coordinates from one reference ellipsoid to another To develop knowledge and skills on geodetic positioning and calculation on the reference ellipsoid and to complete ralevent computation tasks 6.1 To describe the geometry of ellipsoid, relationships of different coordinates and perform coordinate conversions 6.2 To describe normal sections and compute their curvature radii and arc lengths 6.3 To describe the geodesic and compute measurement corrections 6.4 To solve direct and inverse (geodesic) problems 6.5 To describe and compute Puissant's solution and Gauss' mid-latitude solution for direct and inverse problems 6.6 To be able to compute relative positions on the reference ellipsoid To develop knowledge and skills on geodetic positioning and calculation on mapping plane, and to complete ralevent computation tasks 7.1 To explain general concepts of map projection 7.2 To describe the geompositioins on a conformal map for try of mapping an ellipsoid onto a plane 7.3 To describe the Cauchy-Riemann equations 7.4 To explain the characteristics of UTM and MTM projections 7.5 To be able to perform map projection and calculation on mapping plane, specifically able to transform relative position and object representations
Prerequisites	LE/ENG 2110 / LE/ESSE 2610 "Geomatics and Space Engineering"; LE/ENG 2120 / LE/ESSE 2620 "Fundamentals of Surveying"; SC/MATH 2015 "Applied Multivariate and Vector Calculus"; LE/CSE 2501 "Fortran for Scientists and Engineers"; or permission of the course director.
Co-requisites	LE/ENG 3120 / LE/ESSE 3620 "Adjustment Calculus".

INSTRUCTOR	
Instructor name	Jian-Guo Wang, Dr.-Ing., P.Eng.
Office location	PSE 245
Office hours	14:00~16:00, Thursdays or per appointments
Contact information	Tel: 416-736 2100x20761 Email: jgwang@yorku.ca
TEACHING ASSITANT(s)	
Teaching Assistant name(s)	Maninder Gill
Office location	TBD
Office hours	TBD
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GRADING BREAKDOWN		
Assessment	**Weight**	**Due Date (or examination date)**
#1, #2, #3, #4, #5, #6	100points for each 35% in the final marks	See the table below and the attached assignment documents

Date		Task
September	12	Lab #1: Presented and explained
	19	Lab #1: Workshop
	26	Lab #1: DUE Lab #2: Presented and explained
October	03	Lab #2: Workshop
	10	No classes. Thanksgiving
	17	Lab #2: DUE Lab #3: Presented and explained
	24	Lab #3: Workshop
October	31	Lab #3: DUE Lab #4: Presented and explained
	07	Lab #4: Workshop
	14	Lab #4: DUE Lab #5: Presented and explained
	21	Lab #5: Workshop
	28	Lab #5: DUE Lab #6: Presented and explained
December	05	Lab #6: DUE

COURSE TEXTS	
Required texts and materials	Vanícek, P., and E. Krakiwsky (1986). *Geodesy: The Concepts*. North Holland, Amsterdam (2nd Edition). Notes: - We will treat only the subjects included in Chapters 15 and 16. - The book is out of print and currently under revision (3rd Edition). - The book is on reserve at the Steacie Science and Engineering Library (2 hour limit)
Suggested texts and materials	• Anderson, J.M., and E.M. Mikhail, (2012): *Surveying: Theory and Practice*. McGraw-Hill, Boston (7th Edition). • El-Rabbany, A. (2006): *Introduction to GPS, the Global Positioning System*, 2nd edition, Artech House, Boston, 2006. • Seeber, G. (2003): *Satellite Geodesy*, 2nd edition, Walter de Gruyter, Berlin, 2003 • Torge, W. and Müller, Jürgen (2012): *Geodesy*, Walter de Gruyter. Berlin (4th Edition).

	• Wertz, J.R., and W.J. Larson (eds.), (1999). *Space Mission Analysis and Design*. Microcosm and Kluwer, (3rd Edition). • C.D. Ghilani and Wolf, P.R. (2014), *Elementary Surveying: An Introduction to Geomatics*. Prentice Hall, New Jersey (14th Ed).
Other materials	From time to time you will receive handouts dealing with specific topics. This material will normally comprise examples and will be the source for your test / exam preparation.

DESCRIPTION OF COURSE ASSESSMENTS

Assessment	Description
Laboratories (6)	35%
Mid-term examination	20%
Final examination	40%
Class participation	5%

Grading, Assignment Submission, Lateness Penalties and Missed Tests

Grading

During the term, marks will be given in percent. Final marks from weighted averages will be converted to letter grades according to University regulations:

Percentage	Grade	Description
≥90%	A+	Exceptional
80-89%	A	Excellent
75-79%	B+	Very Good
70-74%	B	Good
65-69%	C+	Competent
60-64%	C	Fairly Competent
55-59%	D+	Passing
50-54%	D	Marginally Passing
48-49%	E	Marginally Failing
<47%	F	Failing

WEEK BY WEEK LECTURE SCHEDULE

IMPORTANT DATES

Fall Class Start: Thursday, September 08, 2016
Fall Class End: Monday, December 05, 2016
Reading Days: Oct. 27 – 30, 2016
Statutory Holiday(s): Thanksgiving Day, Monday, Oct. 10, 2016
Fall Exams Start: December 7, 2016
Fall Exams End: December 22, 2016

Date		Lecture
September	08	Introduction – Course outline and requirements. Geodesy: definition,

		tasks and problems. Point positioning.
	13	Fundamentals of geodetic astronomy. Celestial sphere and celestial Coordinate systems. Precession, nutation, polar motion. Coordinate system transformations.
	15	Local astronomical system. Local Astronomical (LA) coordinate system. Observations in the LA.
	20	Instantaneous Terrestrial (IT) system. Transformation: LA to IT. Transformation: IT to Apparent Places (AP) system.
	22	Review: AP, LA, and IT and their transformations. Hour angle and LAST.
	27	Astronomical positioning.
	29	Polar motion and Conventional Terrestrial (CT) system. Transformation between IT and CT. Aberration, parallax and refraction
October	04	True Right Ascension (TRA) system. Mean Right Ascension (MRA) system. Transformation between TRA and MRA. Ecliptic (E) system.
	06	Time systems. Solar time. Sidereal time. Atomic time.
	11	Modern reference coordinate systems: International Celestial Reference System (ICRS); International Terrestrial Reference System (ITRS). Transformations
	13	Geodetic positioning techniques: **Overview** – major branches of geodesy, positioning modes, measurements **Horizontal Positioning Techniques** – astronomical techniques, triangulation, trilateration, traverse; **Vertical Positioning Techniques** – precise leveling, trigonometric leveling, height systems; **3D Geodetic Control Network** – different 3D geodetic control networks, the GNSS baseline network.
	18	**Satellite positioning**: GNSS system architecture, functions of GNSS satellites and their orbits; gravitational forces exerted on an artificial Earth satellite; Keplerian orbits; orbital system (orbital ellipse, normal orbits, orbital coordinate system, six orbital parameters and their functions, orbital anomalies);
.	20	**Satellite positioning**: Satellite's coordinates (planar coordinate system, orientation elements, transformation from orbital to celestial, to terrestrial systems); orbital perturbations; orbit determination (Keplerian orbit, perturbed orbit); orbit dissemination (TLE, Yuma, GPS broadcast ephemeris, GPS SP3); Satellite positioning methods and models (point positioning, range model, SPP, static & kinematic relative positioning, etc.); Laser ranging (SLR, LLR).
	25	Mid-term Examination

	27	Reading Days (~ Oct. 30)
November	01	**Geodetic Systems/Datums**: Datum (definition, horizontal & vertical datums); reference ellipsoids; vertical datum (general, geoid, Earth's gravitational field & model, Canadian Height Reference System Modernization and CGVD2013); World Geodetic systems (history, WGS84, WGS84 & ITRF, WGS84 & NAD83)
	03	**Geodetic Systems/Datums**: North American Datum (NAD27, NAD83, NAD83 CSRS, transformations); GNSS Reference coordinate systems. **Geodetic Calculations on Ellipsoid**: Ellipsoidal Geodesy; ellipsoid; reference ellipsoids and geodetic datum; basic geometrical parameters; coordinate systems on ellipsoid
	08	**Geodetic Calculations on Ellipsoid**: Relations of different coordinates (meridian plane and geodetic coordinates, reduced latitude, geocentric latitude); Latitude/Longitude/Ellipsoidal height and Cartesian XYZ; normal sections and their curvature radii (meridian, prime vertical, equator, parallel circle, general normal circles, Euler's equation).
	10	**Geodetic Calculations on Ellipsoid**: Arc lengths (Geodesic and Clairaut's equation, differential equations, arc length of meridian and parallel circle); measurement reduction to ellipsoid (field measurements, three basic requirements, tasks, Deflection of vertical and Laplace equation, three corrections for directions, distance measurement corrections).
	15	**Geodetic Calculations on Ellipsoid**: Direct and inverse problems – two fundamental geodetic calculations; method classifications; Formulae based on differential equation of geodesic (Puissant's solution, series expansion, Legendre-Series, Gaussian Series with mid-latitude); Bessel's formula (concept, three mapping conditions, relationships between ellipsoidal and spherical elements, solution for direct and inverse problems)
	17	**Map Projections**: Introduction (concept, examples of different maps); processing flow of measurements; developable surfaces (cone, cylinder, plane); distortions and Tissot's indicatrix; distance distortion
	22	**Map Projections**: Angle and area distortion; classification of map projections (types after distortions, projection surfaces, aspects of projections and viewpoints); typical projections in Geodesy
	24	**Map Projections**: Gauss-Krüger projection; Cauchy-Riemann equations (scale factor, isometric latitude, Cauchy-Riemann equations); projection equations (latitude/longitude to (x, y))
	29	**Map Projections**: Projection equations (latitude/longitude from (x, y)); meridian convergence (by

		latitude/longitude and by (x, y)); direction correction; distance correction; transformation between two neighboring zones; UTM Coordinate System;
December	03	**Map Projections**: MTM Coordinate System (concept, MTM key map for Canada, 3^o MTM maps in Canada); Other map projections used in Canada. Course Review.

COURSE POLICIES

Assignment Submission

Proper academic performance depends on students doing their work not only well, but on time. Accordingly, assignments for this course must be received on the due date specified for the assignment. Assignments are to be handed in at the beginning of the laboratory period they are due.

Lateness Penalty

Assignments received later than the due date will be penalized **20% per day** that assignment is late. Late assignments must be submitted in person. Exceptions to the lateness penalty for valid reasons such as illness, compassionate ground, etc., may be considered by Instructor, but will require supporting documentation (e.g., a doctor's letter).

Missed Tests

- Students with a documented reason for missing a course test, such as illness, compassionate grounds, etc., which is confirmed by supporting documentation may request accommodation from Instructor. Further extension or accommodation will require students to submit a formal petition to the Faculty.
- The weight of the missed mid-term exam will be shifted to the final exam if you have an officially valid excuse such as a medical doctor's note.

ACADEMIC HONESTY

Important Course Information for Students

All students are expected to familiarize themselves with the following information, available on the York University Secretariat Policies, Procedures and Regulations webpage: http://www.yorku.ca/secretariat/policies/index-policies.html.

- York's Academic Honesty Policy and Procedures / Academic Integrity website
- Ethics Review Process for research involving human participants
- Course requirement accommodation for students with disabilities, including physical, medical, systemic, learning and psychiatric disabilities
- Student Conduct Standards
- Religious Observance Accommodation

FAQs

Question	Answer