York University
Faculty of Science and Engineering

LE/ESSE 3640 3.0

Geodetic Surveys

Winter 2016

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Office Hours: TBD

Lectures *Tuesdays*, 16:00 – 18:00 (4:00pm – 6:00pm), SC302

Laboratory exercises *Fridays*, **11**:30-14:30.
The Engineering Lab (Petrie Sci. and Eng. Building, Room 020)

Office Hours *Tuesday*, 12:00 – 14:00 (12:00 – 2:00pm) and per appointment

Assessment

Laboratories	40%
Mid-term test	15%
Participation	5%
Final Exam	40%

Grade System

≥90%	A+
80-89%	A
75-79%	B+
70-74%	B
65-69%	C+
60-64%	C
55-59%	D+
50-54%	D
40-49%	E
<39%	F

Attention: 1). Students, who miss the project or maximum 3 lab sessions/assignments for any reason, will automatically prevent from passing this course without exception.

2). No make-up mid-term exam will be offered. The weight of the missed mid-term exam will be shifted to the final exam if you have an officaly valid excuse such as a medical doctor's note.

GEERAL COURSE INFORMATION

1. Objectives

- Familiarization with high precision surveying instrument systems.
- Gain knowledge and skills in testing and calibrating of survey instruments according to standards and specifications.
- Acquiring knowledge and skills on and become capable of establishing geodetic control for engineering projects of high accuracy/precision.
- Become capable of applying geodetic theory in high precision monitoring networks.
- Developing skills in data collection, processing, analysis and interpretation via advanced and complex calculations and computer programming.
- Acquiring knowledge and skills on integrating modern positioning techniques for engineering applications

2. Format

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

- Lecture sessions will be conducted in form of discussion and participation. Students are required to participate actively, and design and solve problems by synthesizing knowledge, experience and skills from previous courses.
- The course will be closely related and will be running parallel to SC/ENG3130 4.0 "*Analysis of overdetermined systems*."
- Each session will normally commence with a brief review of the concepts treated previously. New subject(s) will be presented immediately after the review, according to the tentative lecture schedule provided in this handout. **Participation** is an essential element of learning: It will be **encouraged** and **assessed**.
- All sessions will based on, but not limited to the advanced topics of the textbook. Technical papers will also be supplied by the instructor for further studies. The students will be required to actively search relevant literature to further their knowledge.

3. Laboratory and field exercises

- Laboratories are most essential for the development of skills and experience. They will comprise a variety of activities that are usually required in the design, planning, execution, analysis and interpretation of data, and preparation of comprehensive reports.
- Laboratory exercises will be conducted in the lab and in the field depending on weather conditions.
- Laboratory reports will have clear due dates. You are expected to describe in detail methodologies, data processing and analysis, and results and hand in reports and developed software, where applicable.
- Participation in all laboratory exercises is **mandatory**.
- Grades for late laboratory reports will be decreased by 20% per day for each day overdue.

Late lab reports must be handed in personally to your TA.

4. Getting feedback on your progress

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

- Each class session should give you a fair idea how well you have understood the relevant material.
- Laboratory exercises: You will be asked to execute all of the mandatory laboratory exercises, write reports, solve specific computational problems, perform statistical testing and evaluation of observations and solutions and design specific auxiliary equipment of high precision surveys. Your participation is essential and will be assessed.
- Mid-term test.
- Final exam.

5. Announcements

Announcements and information related to the course, such as special lectures, class cancellations, change of due dates, professional activities, Internet links, and others will be emailed to the students. Please check regularly for up-to-date announcements and information.

ACADEMIC INTEGRITY

All students should take the time to acquaint themselves with the university's policy concerning academic integrity in courses. Cheating, plagiarsing amd making unauthorized multiple submissions of academic assignments are not allowed. You are all advised to read about this at http:/www.yorku.ca/academicintegrity ('For students' session), and to complete the Academic integrity tutorial at http:/www.yourku.ca/tutorial/academic integrity/. You should print the results page of your successful quiz and keep it for verification if asked.

Ethical behaviour must be observed at all times.

SAFETY IN LAB AND FIELD

No Job is so important and no service so urgent that we cannot take time to perform our work safety. The following is not intended to be an all-inclusive capsule of safety requirements.

- Students comply with all safety regulations, policies of York University.
- Wear personal protective equipment in all designated areas or when otherwise directed to do so.
- Immediately report to TA or course Director if any safety incident occurs or may occur.
- Each individual in lab or in field has the responsibility and obligation to the other group members to work safely. If one sees another one perform an unsafe act, they should call this to the other person's attention, whether the unsafe act affects only the individual or the whole team.
- The equipment used has the potential to become very hazardous objects and must be

properly secured for travel.

- The survey instruments used should be protected from any potential damage.

COURSE OUTLINE

1. Modern survey instruments – Testing, calibration and operation
2. EDM principles and errors
3. Theodolites – principles, methodologies, errors, filed observation procedures.
4. Total station systems.
5. Height systems, high precision levelling – methodologies, errors, filed observation procedures.
6. GPS filed observation and data processing in geodetic control surveying.
7. High accuracy geodetic control networks.
8. Engineering surveys.
9. Development of data processing software utility for 3D engineering control survey
10. Optimal control network design.

TEXT BOOKS

1. Wang, Jian-Guo (2009): Geodetic Surveys, Lecture Notes, Department of Earth and Space Science and Engineering, York University, revised 2011.
2. Anderson, M.J., and E.M. Mikhail, (1998). Surveying: Theory and Practice. McGraw-Hill, (7^{th} Edition).
3. Vaníček P., and E. Krakiwsky (1986). Geodesy: The Concepts. North Holland, Amsterdam (2^{nd} Edition).

SUGGESTED REFERENCES

1. El-Rabbany, A. (2002). Introduction to GPS, the Global Positioning System. Artech House, Boston.
2. Kavanagh, B.F., (2003). Surveying Principles and Applications. Prentice Hall, New Jersey (6^{th} Edition).
3. Leick, A, (1995). GPS Satellite Surveying. John Wiley, New York (2^{nd} Edition).
4. Ghilani, C.D. and Wolf, P.R. (2006), Adjustment Computations: - Spatial Data Analysis, John Wiley & Sons (4th edition), 2006.
5. Mikhail, E.D., and G. Gracie, (1981), Analysis & Adjustment of Survey Measurements, Van Nostrand Reinhold.
6. Wolf, P.R., and C.D. Ghilani, (2002). Elementary Surveying. An Introduction to Geomatics. Prentice Hall, New Jersey (10^{th} Edition).
7. Research papers provided by the instructor.

TENTATIVE CLASS SCHEDULE

Winter Class Start: Sunday, January 02, 2016
Winter Class End: Monday, April 04, 2016
Reading Week: February 13 – 19, 2016

Statutory Holiday(s): Family Day, Feb. 15, 2016
Good Friday, March 25, 2016 (Makeup-date: Monday, April 4, 2016)

Winter Exams: April 06~20, 2016

Date	*Subject*
January 05	**Introduction** – Course outline and requirements. **Modern survey instruments** – Instrument handling and care (3.10[*]), need for testing and adjustment of equipment (3.11). **Precise Distance taping; EDM (Electromagnetic Distance Measurement)**: principles and classification (4.27– 4.32), and systematic errors (4.38). [*] – ***the numbers in parentheses refer to*** the section number(s) in "Anderson, M.J., and E.M. Mikhail, Surveying: Theory and Practice. McGraw-Hill, (7th Edition), 1998." (sic passim).
January 12	**EDM:** Non-linearity in EDM; tests and calibration (4.39– 4.42) and EDM distance reductions (4.43–4.48).
January 19	**Vertical Control**: Curvature & Refraction (5.2), precise levelling instruments, their errors, calibration, field observation and specification (5.46 - 5.54), Trig levelling, the EDM trigonometrical levelling and barometric levelling (5.1–5.6 and 5.55–5.56).
January 26	**Vertical Control**: Height systems, profile levelling (5.43 – 5.45) and reciprocal levelling (5.54), data processing (5.39, 5.40, 5.42, 5.57, 5.58 and 5.59).
February 02	**Horizontal control**: Wild Precise Theodolites, Zeiss Theo Theo 010, Electrical Digital Theodolites, Measurement of vertical angles, Total station systems (7.16 – 7.21) and ECD, Instrument Errors.
February 09	***Mid-Term exam* (*90 minutes*); Horizontal control (cont'd)**: instrument testing and adjustment.

Reading Week: February 13 – 19, 2015

February 23	**Horizontal control (cont'd):** Field Procedures, station adjustment, tolerance errors for multiple sets of filed observation; MagDrive Servo Technology for vertical axle system of total station systems.
March 01	**GPS in Control Surveying (12.1 – 12.15)**: GNSS techniques, receivers, observation methods, receiver Testing – zero baseline test, short baseline test, antenna phase center problem, applications – Canadian active control system, active control points, GPS validation networks.
March 08	**GPS in Control Surveying (cont'd)**: applications – direct georeferencing;

	Observation Planning, data processing.
	Deformation monitoring and data analysis: deformation and its monitoring, free network
March 15	**Deformation monitoring and data analysis (cont'd):** data analysis and applications
	Geodetic Projects: Generals, Network Design and software-aided Network design, pre-analysis.
March 22	**Geodetic Projects (cont'd):** High accuracy engineering surveying applications, Overview of deformation surveys, Geodetic control networks, Terrain laser scanning in Engineering surveying.
March 29	**Geodetic Projects (cont'd):** Large scale engineering project - Øresund fixed link between Denmark and Sweden**;** (Optional) introduction to different types of Control Surveys in Engineering Surveying**; Course Review**.

LABORATORY AND FIELD WORK
TENTATIVE SCHEDULE

Date ***Subject***

January 08 ***Proejct Session #1: Project - Software Utility for 3D Engineering Control Network Adjustemnt***

January 15 Lab#1: EDM Zero error determination on unknown and known baseline and EDM scale error using a known baseline.

January 22 Lab#2: EDM cyclic error determination.

January 29 Lab#3: Determination of the collimation error of precise levels

Project update #1: components 1 and 2

February 05 Lab#4: High precision Levelling.

(The field operation needs six students in a group)

February 12 Lab#5: Theodolite/Total Station Testing and Adjustment.

Reading Week: February 13 – 19, 2016

February 26 ***Project Session #2 (and Project update #2)***: component 3

March 04 Lab#6: Establishment of a small scale of 3D control network using Total Station TC1800 (or TCA1800) (and geodetic GPS receivers in the following lab)

March 11 Lab#7: GPS Baseline Observation and Processing

Project update #3: components 4

March 18 Lab#8: Control Network Data Processing

April 01 Lab#9: Network Design/Accuracy Pre-analysis

April 04 ***Project Session #3***: component 5, completion