

Canadian Board of Examiners for Professional Surveyors
Core Syllabus Item
C 3: ADVANCED SURVEYING

Syllabus Topics:

Formulation of equations relating desired quantities to observable quantities and the propagation of variances through these equations; simulation [pre-analysis] and design of surveys in 1, 2, or 3 dimensions; error analysis of resultant data.

Application of optical and electromagnetic and other electronic measuring principles and techniques; azimuth by non-astronomic methods [derived from plane or geodetic coordinates, observed using a gyro-attachment or gyrotheodolite]; testing and calibration of surveying instruments; specifications for instrument quality evaluation; utilization of surveying instruments.

Engineering surveys [including high precision and deformation surveys]; underground surveys [tunnelling control or mining]; horizontal and vertical control for geomatics activities, esp. cadastral surveys, mapping, and construction projects.

Critical values of the χ^2 distribution and a collection of formulae are provided with the examination questions.

Recommended Prior Knowledge and Skills:

Item C 1: Mathematics

Item C 2: Least-Squares Estimation and Data Analysis

Courses or extensive experience in “plane” surveying, including at least: horizontal and vertical relative positioning, topographic surveying, route design and setting out and related quantity calculations; three dimensional traversing; familiarity with commonly used surveying instruments [preferably of high precision: theodolites, tapes, EDM, levels, total stations], procedures, and recording in field notes.

Learning Outcomes:

In order to satisfy the requirements of this syllabus item, candidates should be able to:

1. Discuss the concept of precision as it relates to surveying processes: the sources and types of random errors and their quantification.
2. Discuss the concept of accuracy as it relates to surveying processes: the sources and types of systematic errors and how to deal with them.
3. Prescribe the procedures and quality assurance measures for: the testing and

- calibration of surveying instruments; measurements of high precision; underground surveying; and non-astronomic observations for azimuth. Assess the results of any of these.
4. Design the appropriate combination of equipment and procedures for a data gathering task that will ensure that the gathered data meets the quality requirements of relative positioning (horizontally or vertically or in three dimensions simultaneously).
 5. Translate specifications such as maximum allowable misclosures [angular or linear] into a choice of equipment and procedures for horizontal or height or three-dimensional traversing.
 6. Compose specifications and requirements [standards and quality assurance procedures] for gathering survey related data.
 7. Differentiate between the processes that result in position information and the processes that require repeated positioning for local deformation monitoring.
 8. Discuss the implication of repeated measurements for long-term monitoring with respect to systematic and random influences on the measurement systems.

Topic Areas and Recommended Reading Order of Essential Reference Material:

Design, Simulation, Error Analysis:

Ogundare [2015], Surveys & Mapping Branch [1978], Geodetic Survey Division [1992, 1993], Donahue et al. [2013]

Instrumentation, Testing, Utilization:

Ogundare [2015], Ghilani & Wolf [2015]

Engineering Surveying:

Ogundare [2015]

Underground Surveying:

Ogundare [2015]

Control:

anon. [2007a], Ghilani & Wolf [2015], Ogundare [2015], Surveys & Mapping Branch [1978], Donahue et al. [2013]

Essential Reference Material:

prefix on items that are available from CBEPS for downloading.

anon. [2007]. *Engineering Design: Control and Topographic Surveying*. United States Army, Corps of Engineers, Engineer Manual EM 1110-1-1005, 498 pp. available via http://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_1110-1-1005.pdf or web-search “Engineer Manuals”.

A readily available comprehensive overview with useful references, especially regarding control surveys.

Donahue, B., J. Wentzel, and R. Berg [2013]. *Guidelines for RTK/RTN GNSS Surveying in Canada*. version 1.1. Natural Resources Canada, Earth Sciences Sector. 29 pp [via ftp://ftp.nrcan.gc.ca/ess/sgb_pub/CS > by searching title]

Geodetic Survey Division [1992]. *Guidelines and Specifications for GPS Surveys*, Release 2.1, 1992 12, Geodetic Survey Division, Canada Centre for Surveying, Surveys, Mapping and Remote Sensing Sector, Natural Resources Canada, Ottawa. [via <http://www3.sympatico.ca/craymer/geodesy/pubs.html>]

Geodetic Survey Division [1993]. *GPS Positioning Guide*, (1993 07) 3rd printing 1995 07, Geodetic Survey Division, Geomatics Canada, Natural Resources Canada, Ottawa. [via <http://www3.sympatico.ca/craymer/geodesy/pubs.html>]

Ghilani, C.D. and P.R. Wolf [2015]. *Elementary Surveying: An Introduction to Geomatics*, 14th edition, Prentice Hall Canada Inc., ISBN-13 978-0-13-375888-7 or ISBN-10 0-13-375888-5, hardcover. [the Global Positioning System (ch. 13, 14, 15), control surveys (ch. 19)]

Ogundare, J.O. (2015). *Precision Surveying: The Principles and Geomatics Practice*, 648p., October 2015, Wiley & Sons, Inc., Hoboken, New Jersey, ISBN: 978-1-119-10251-9, website: www.wiley.com/buy/9781119102519

Supplementary Reference Material:

Candidates may find these references useful, in addition to those listed as essential.

Geodetic Survey Division [1996]. *Accuracy Standards for Positioning*, Version 1.0, 1996 09, Geodetic Survey Division, Geomatics Canada, Ottawa. [via <http://www3.sympatico.ca/craymer/geodesy/pubs.html>]

Schomaker, M.C. and R.M. Barry [1981]. *Geodetic Leveling* NOAA Manual NOS NGS 3, 1981 08, National Geodetic Survey, National Ocean Survey, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. [networks (ch. 1), sources of error (sec. 3.1)]

#Surveys and Mapping Branch [1978]. *Specifications and Recommendations for Control*

Surveys and Survey Markers, Specifications Series, Surveys and Mapping Branch, Energy, Mines and Resources Canada, Ottawa. [Useful for types of survey markers and vertical control using levelling; otherwise superceded by Geodetic Survey Division (1996)]