CBEPS CCEAG

Canadian Board of Examiners for Professional Surveyors

Conseil canadien des examinateurs pour les arpenteurs-géomètres

S4 - Surveying

Content

- This document is a high-level curriculum design which captures the principles, competencies, learning outcomes and syllabus items proposed for the updated curriculum specific to S4 – “Surveying”

S4: 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	**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

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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 • Basic observables: slope distances, horizontal directions, 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

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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	• 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	**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

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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
		  ○ Site planning survey
		  ○ Topographic survey
		  ○ Control survey
		  ○ Oil and gas survey
		  ○ Mining 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

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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

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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.