Course PM

General information and intended learning outcomes

Global navigation satellite systems (GNSS) have become a common tool not only for navigation but also for the collection of detailed geographic data, i.e. for applications where cm or mm accuracy is required. Topographic surveying or establishment of geodetic control networks are examples of such applications. The aim of the course is to gain theoretical and practical knowledge on the GNSS, which is necessary to plan, implement and process GNSS observations. The course provides knowledge and skills in terrestrial photogrammetry and its use for collection of detailed geographic data.

After the course, the students should be able to:

- Identify which satellite observations can be used for positioning and explain how they can be used for calculation of position and speed of a receiver (Lectures [1)], Exam [2)], Home assignment [2)])
- Identify components of GNSS and explain their function (Lectures [1)], Exam [2)])
- Plan, carry out and process GNSS observations by means of advanced geodetic receivers in order to establish geodetic networks, perform detail surveying and setting-out and to determine trajectory of a vehicle (Labs [1),2)], exam[2)])
- Evaluate quality of coordinates determined by GNSS observations (Labs [1),2)], Exam [2)])
- Transform the coordinates into given reference system (Labs [1),2)], Exam)
- Explain principles of image-based topographic measurement (Lectures [1)], Exam [2])
- Combine GNSS and terrestrial observations (Labs [1),2)], Exam [2])

1) Trained

2) Examined

Literature

Hofmann-Wellenhof, Lichtenegger, Wasle (2008). GNSS. Springer. Wien, New York

HMK – GNSS-baserad detaljmätning 2017

HMK – Stommätning 2017

Lecture slides

Course activities

The course is worth 6 credits, which corresponds to 4 weeks of work. During the course you will obtain both theoretical and practical knowledge and skills in GNSS surveying and its combination with total station and terrestrial photogrammetry. The course activities consist of

7 lectures (2 hours each), 3 field measurements (4 hours each), 4 computer labs (3 hours each) and a home assignment.

It is obligatory to attend the field measurements, other attendance in not obligatory. You are supposed to write and submit reports for the computer labs. You can perform the labs and with the reports individually or you can work together with a classmate.

Requirements for final grade

To pass the course you must

- be approved on all lab reports including home assignment
- pass written examination

Grading criteria:

A, B: submit all lab and project reports in time, No, or only minor corrections necessary. Answer correctly, or with minor uncertainties, all questions for written (home assignment) and written examination.

C,D : submit most of the lab and project reports in time. Some corrections are necessary. Answer all questions for written (home assignment) and written examination, several questions are answered just partially or with uncertainties.

E, FX: submit all lab reports, larger corrections are necessary. Answer most of the questions just partially and or with greater uncertainty.

Credits and grades

Examination

LAB1 – Laboratory work, 3,5, grading scale: P, F

TEN1 – Written examination, 2,5, grading scale: A, B, C, D, E, FX, F

Course content

Lecture 1:

October 28, 2019, 13-15, Taiga

Introduction to course, Historical overview of satellite techniques. Components of the system and their functions: satellites, control stations, GNSS receivers.

Reading:

Chapter 1 Introduction and Chapter 9 GPS

Lecture 2:

November 1, 2019, 10-12, Taiga

Reference and time systems relevant to GPS. Orbit description, GPS ephemeris: almanac, broadcast and precise ephemeris. Satellite signal.

Reading:

Chapter 2 Reference systems and Chapter 3 Satellite orbits (just principles, no equations are required)

Exercise 1 (Fieldwork)

November 6, 2019, 8 - 12, instrument store

Static GNSS measurements.

Lecture 3

November 6, 2019, 14-16, BoraBora

Types of GPS observables, error sources and the way of their elimination, error budget. Antenna calibration and models.

Reading: Chapter 4 Satellite signal and Chapter 5 Observables, excluding 5.2 Data combinations and 5.4 Relativistic effects (just principles, no equations are required)

Exercise 2 (Fieldwork)

November 8, 2019, 8 - 12, Instrument store

RTK GPS. Starting reference receiver, surveying, setting out and tracking.

Lecture 4

November 11, 2019, 10 - 12, Taiga

Mathematical models for positioning, observation techniques, differential GPS, relative positioning,

Reading:

Chapter 6 Mathematical models for positioning, Chapter 7.3.4 Dilution of precision

Lecture 5

November 14, 2019, 10 -12, Ocean

Geodetic control networks. Type of networks. Main steps in establishment of geodetic control networks. Planning a GNSS survey. GNSS network design, surveying procedure.

Reading:

HMK-Stommätning

Lecture 6

November 18, 2019, 13 - 15, Taiga

Network adjustment, Combination of terrestrial and GPS measurements. Transformations: connecting GPS measurements to local reference systems.

Reading:

Chapter 10 from compendium Lantmäteriet m.fl. 2012: Geodetisk och fotogrammetrisk mätnings- och beräkningsteknik.

Chapter 10 Transformation of GPS results

Exercise 3 (Fieldwork)

November 22, 2019, 8 - 12

Integrated Survey (RUFRIS). Image based surveying.

Exercise 4 (Computer lab)

November 25, 2019, 9-12, M102

GPS software Trimble Business Center, processing of static observations from Exercise 1.

Lecture 7:

November 27, 2019, 10 - 12, Sahara

Image based surveying: terrestrial photogrammetry

Reading:

Chapter 15.4 Markfotogrammetri from compendium Lantmäteriet m.fl. 2012: Geodetisk och fotogrammetrisk mätnings- och beräkningsteknik.

Exercise 5 (Computer lab)

November 27, 2019, 13 -16, M102

Definition of reference system and cartographic projection in GPS software.

Planning static GNSS observation.

Lecture 8

December 2, 2019, 13 - 15, Taiga

Catch-up from previous topics. Geodetic networks + least squares.

Exercise 6 (Computer lab)

December 4, 2019, 13 - 16, M102

Least squares adjustment: Computation of coordinates and orientation of total station using GNSS observations.

Exercise 7 (Computer lab)

December 9, 2019, 9 - 12, M102

Establishment of control network using GNSS and terrestrial observations and image based surveying - data processing.

Exercise 8 (Seminar)

December 13, 2019, 13 - 16, Arctic

Peer review

Lecture 9:

Date: will be determined later

Help for preparation for examination