UNIVERSITEIT GENT

# Studiefiche

Academiejaar 2017-2018 t.e.m. 2018-2019

## Hydrographic Surveying (C003428)

Cursusomvang (nominale waarden; effectieve waarden kunnen verschillen per opleiding)

| | | | | | |
|---|---|---|---|---|---|
| Studiepunten | 6.0 | Studietijd | 180 u | Contacturen | 48.0 u |

Aanbodsessies en werkvormen in academiejaar 2018-2019

| | | | |
|---|---|---|---|
| A (jaar) | Engels | hoorcollege | 40.0 u |
| | | veldwerk | 8.75 u |

Lesgevers in academiejaar 2018-2019

| | | |
|---|---|---|
| De Wulf, Alain | WE12 | Verantwoordelijk lesgever |

| Aangeboden in onderstaande opleidingen in 2018-2019 | stptn | aanbodsessie |
|---|---|---|
| Postgraduate Hydrography B | 6 | A |

Onderwijstalen

Engels

Trefwoorden

Bathymetrie, multibeam, singlebeam, echosounder, dieptemetingen, radioplaatsbepalingssystemen

Situering

Students will be given insight in horizontal and vertical positioning, orientation. Students will learn the basics of theory and tools used in bathymetry and how to operate these tools. Single-beam echosounder, multibeam swat echosounder, sidescan sonar, interferometry and non-acoustic bathymetric techniques will be teached well since these are essential in the Hydrographer's life.

Inhoud

1. HYDROGRAPHIC SURVEYING (partim 1)
Hydrographic instruments
**a. horizontal and vertical positioning**
Horizontal positioning fundamentals
- Horizontal control surveys
- Horizontal positioning procedures (e.g. intersection, resection, polar and traverse)
- Appropriate instruments
- Economic and logistical aspects of providing control

Angular measurements
- Principles of sextants and theodolites as used for horizontal positioning
- Use sextants and theodolites and evaluate errors

Distance measurements
- Principles of stadia, microwave, infrared and laser systems, as used for measuring distances and distance LOPs. Distance measurement equipment

Vertical positioning fundamentals
- Characteristics of height systems (e.g. dynamic, orthometric and normal heights)
- Gravity-related and ellipsoidal heights

Datums
- The role of, and methods of establishing, the various vertical datums used in hydrographic operations (e.g. Chart, Sounding, MSL, LAT, LW, and HW datums)

Electromagnetic positioning
- Principles of pulsed, differencing (phase and time) and range and bearing systems, utilising both radio and optical frequencies. Operate appropriate systems

Satellite positioning
- GNSS concept and principles
- Characteristics of various public and private DGNSS services (single baseline, network, state space)
- Pseudoranging and carrier phase based modes of satellite positioning

- Performance of code vs. carrier; differential vs. autonomous modes; dual vs. single frequency; fixed vs. float ambiguity resolution. Operate GNSS and DGNSS equipment

Acoustic positioning concepts

- Principles of long, short and supershort baseline acoustic positioning system modes. The deployment and calibration, signal structure, sources of error, and expected uncertainties for each mode

**b. single beam echo sounders**

- Narrow beam and wide beam transducers
- The transducer characteristics that affect beam width
- The piezo-electric principle and its application to transducers
- The arrangement of single element and multielement array transducers
- The methods of mounting transducers: hull, towed, over the side, and boom
- The calibration of an echo-sounder by bar check, leadline, sound speed profile measurements and CTD measurements

**c. side scan systems**

- The effect on side scan sonar performance (range, resolution, target detection) of frequency, beam angle, range scale, gain, towing speed, towing height, and deployment (deep tow, shallow tow, pole mount)
- The set up, deployment and operation of a side scan sonar, for specific applications
- Using available software tools, plot and position sonar contacts and create side scan mosaics
- The determination of height and size of obstructions from sonar records
- The sources of side scan image distortion
- Sonar signatures of such items as debris from wrecks, pipelines, gas, fish and fresh water

**d. multibeam and SWAT echosounder**

- The combination of transducer elements into transmit and receive arrays
- The basic principles of multibeam sonar transmit and receive beam forming and beam steering
- The dependence of depth coverage and uncertainty on bandwidth, beam-width, swath width, beam elevation angle, grazing and incident angles, depth, pulse repetition rate
- Prediction of the nominal sounding density on the seafloor using available information for depth, vessel speed, beam dimensions, and total swath angle
- The generation of backscatter data and the various modes of backscatter recording (e.g., beam average, side scan time series, beam time series)
- The effects on depth and position uncertainty of uncertainty in sensor locations, system latency, and alignments within the vessel reference frame
- Definition of the "patch test"

**e. ROV**

- types
- use of the camera, diver and ROV in the inspection of sea floor contacts

**f. real-time data acquisition and control**

- introduction

**g. management, processing and analysis of acquired data**

- introduction
- Methods for estimating and approximating static and dynamic survey measurements
- Analyze filtering and cleaning functions using appropriate softwar

**h. satellite systems**

- Different satellite positioning systems and for each, their role (primary positioning system or overlay) and orbit geometry (e.g. inclination, ellipticity, altitude)
- Satellite observables
- Satellite coverage and availability

**i. sextant and theodolite used for bathymetric data acquisition**

- Use sextants and theodolites and evaluate errors

**j. errors**

2. HYDROGRAPHIC SURVEYING (partim 2)

**HORIZONTAL POSITIONING**

Sources of errors

- Sources and magnitudes of errors for each positioning method and system
- Problems due to multipath, interference, reradiation, geometry, time-sharing, and power supplies

Performance of each system to be used

- Monitoring of system performance by analyzing results of least squares adjustments of measurements, where appropriate
- Repeatability, relative and absolute accuracies

Deployment

- Hydrographic control stations

**VERTICAL POSITIONING**

Elevation measurements & computations
- Methods for determining differences in elevation (e.g. by spirit level, vertical angle, and GNSS)
- Computation of the elevations from observed data
- Corrections for effects of curvature and refraction, where appropriate
- Principles of satellite altimetry

Heave
- Principles and limitations of heave compensation systems
- The role of filtering in making heave measurements

**ORIENTATION**
- The operation of heading sensors (e.g. flux-gate and other magnetic, fibre-optic and gyro compasses)
- The principles of inertial roll and pitch sensors
- The principles and limitations of GNSS attitude sensors

**BATHYMETRY**

**UNDERWATER ACOUSTICS**

Acoustic fundamentals
- Plane and spherical waves
- Sound speed and particle velocity
- Active Sonar Equation
- Acoustic units
- Intensities
- Sound levels

Generation of Acoustic Waves
- How acoustic waves are generated
- Source level, frequency, wavelength, amplitude,
- Pulse duration (pulse length), and pulse repetition

Transmission of Acoustic Waves
- Causes of propagation loss
- Differences in water properties that affect propagation loss

Sound Speed and Refraction
- Effects of the physical properties of water on sound speed
- Calculation of sound speed from temperature, pressure, and salinity
- Using software tools, create a sound speed with the profile of the water column
- Effects of variation of sound speed in the water column on the path of sound rays

Reflection and Scattering of Acoustic Waves
- Characteristics of the seafloor that affect the reflection of acoustic waves

Acoustic Noise and the Directivity Index
- The sources of noise in the environment
- The effect of noise on echo sounding
- The directivity index

Reception of Acoustic Waves and System Performance
- Beam width, bandwidth, gain, detection threshold
- Range resolution and spatial resolution

Acoustic Devices
- The purpose and operation of acoustic devices such as: transponders pingers, acoustic releases, and sound speed meters. Operate such acoustic devices

Data recording
- Analogue and digital recording systems and media
- The selection of the appropriate range, scale, and pulse repetition rate for specific applications
- The interpretation of echosounder records

Sounding reduction
- The reductions to measured depths due to water level variations, draft, dynamic draft (settlement, sinkage, squat, fuel depletion, and buoyancy)

Sounding accuracy changes and sound speed
- The use of available uncertainty values for individual sensors,
- The calculation and assessment of the uncertainty in soundings due to errors in the positioning system, echo-sounder, water level measurement, vessel motion and sound speed

Acoustic sweeps
- The design of boom systems and the effect of transducer spacing and survey speed on full insonification

System selection
- The primary system characteristics that affect range resolution, spatial resolution, depth capability, and bottom penetration. The effect of changes in those characteristics

Multibeam
- The principles and geometry of multibeam echo sounding

Reference Surface
- The concept and process of establishing a reference surface and assessing the performance of an integrated survey system

**PHASE DIFFERENCING BATHYMETRY (INTERFEROMETRY)**

Phase Differencing Systems

- The principles and geometry of interferometry
- Phase differencing bathymetric sonars
- Arrangement of transducer arrays

Deployment and mounting

- Options for deployment and mounting of phase differencing systems

**NON-ACOUSTIC BATHYMETRIC TECHNIQUES**

Laser bathymetry

- The principles, capabilities, and limitations of bathymetric lidar
- Environmental and operational environments in which bathymetric lidar surveys are complementary to echo sounder surveys
- a Secchi Depth and list which environmental factors affect it

Remote sensing bathymetry

- The techniques of passive remote sensing for bathymetry
- Other airborne, shore-based, and satellite active remote sensing techniques for bathymetry

Mechanical techniques

- Wire and bar sweeps

Begincompetenties

- Bachelor’s degree or equivalent
- Good knowledge of mathematics
- Good knowledge of physics
- Good knowledge of English

Eindcompetenties

1. Ability to understand the questions of positioning at sea (horizontal, vertical) and to calculate or derive positions.
2. Ability to identify, use and apply the right bathymetric tools for a given situation.

Creditcontractvoorwaarde

Toelating tot dit opleidingsonderdeel via creditcontract is mogelijk mits gunstige beoordeling van de competenties

Examencontractvoorwaarde

Dit opleidingsonderdeel kan niet via examencontract gevolgd worden

Didactische werkvormen

Hoorcollege, veldwerk

Leermateriaal

Syllabus

Slides will be available in addition of the following required textbooks:

- IHO Manual on Hydrography C-13 2005/2011
- IHO Standards of competence edition S5 2010
- Handbooks Of Offshore Surveying, 2nd Edition - 3 Volumes, Editors: Huibert-Jan Lekkerkerk & Maarten-Jan Theijs, Publisher: Skilltrade BV

Referenties

IHO Standards of competence edition S5 2011

Vakinhoudelijke studiebegeleiding

Interactieve ondersteuning via Minerva. Persoonlijk contact met lesgevers tijdens decontacturen of na elektronische afspraak. De studenten kunnen bovendien beroepdoen op de practicum-assistenten alsook op de studiebegeleiders die de vakgroepgeografie jaarlijks voorziet.

Evaluatiemomenten

periodegebonden en niet-periodegebonden evaluatie

Evaluatievormen bij periodegebonden evaluatie in de eerste examenperiode

Schriftelijk examen, mondeling examen

Evaluatievormen bij periodegebonden evaluatie in de tweede examenperiode

Schriftelijk examen, mondeling examen

Evaluatievormen bij niet-periodegebonden evaluatie

Portfolio, participatie, werkstuk, verslag

Tweede examenkans in geval van niet-periodegebonden evaluatie

Examen in de tweede examenperiode is mogelijk

Toelichtingen bij de evaluatievormen

- Semester 1: Written/Oral
- Semester 2: Permanent evaluation

- Theory examination: quality of knowledge, insight, relation between subjects, ...
- Permanent evaluation; workshops: proof of attendance; portfolio: reports, excercises, ...

Eindscoreberekening

The final figure of assessment is composed of:

- 50% semster 1 (exams)
- 50% semester 1 & 2 (permanent evaluation)