Exam: Geodesy and Positioning (GIS-E1010) 07.04.2017

(Function calculator)

1. **Fundamentals**

   (a) [3p] The flattening of the Earth. How does the interior distribution of the Earth's masses influence her flattening? The ideas of Newton and Huygens and current understanding.

   (b) [3p] Polar motion and length-of-day (LOD) variations. How do they behave and what causes them, as well as available observation techniques.

2. **Statistics, units**

   (a) [3p] A plane triangle has three angles measured, $\alpha = 62°.10 \pm 0°.02$, $\beta = 67°.57 \pm 0°.03$ and $\gamma = 50°.29 \pm 0°.06$.

      i. Calculate the sum of the measured angles and its uncertainty (mean error) using *propagation of variances*. You may assume the angle measurements to be statistically independent, i.e., uncorrelated.

      ii. *Compare* the values obtained. Conclusion?

   (b) [3p] We have 52 playing cards, with values: the number value 2-10; ace is 1, jack is 11, queen is 12, king is 13. Compute the *expectancy* if a card is drawn blind from the pack.

   Equation:

$$E(\underline{n}) = \sum_{i=1}^{13} i \cdot p(i),$$

   where $p(i)$ is the probability that the card's value is i.

3. **Measurement instruments and methods**

   (a) [2p] What is the *collimation error* of a theodolite, and how does one determine it?

   (b) [2p] The observation equation for code based pseudo-ranges is

$$p = \rho + c(\Delta t - \Delta T) + d_{\text{ion}} + d_{\text{trop}},$$

   where

$$\rho = \sqrt{(x-X)^2 + (y-Y)^2 + (z-Z)^2}.$$

   Explain the meanings of the symbols appearing in the equations.

   (c) [2p] Explain the idea behind the GOCE mission. GOCE = Gravity Field and Steady-State Ocean Circulation Explorer.

4. **Forward and inverse geodetic problems**

   (a) [3p] Given a point A: $x_A = 6\,642\,000\,\text{m}$, $y_A = 502\,000\,\text{m}$. The distance to point B is $s = 1414.214\,\text{m}$ and the azimuth (direction angle) $t = 50\,\text{gon}$. Solve the first (forward) geodetic problem for points A, B.

   (b) [3p] Given is also point C with coordinates $x_C = 6\,640\,000\,\text{m}$, $y_C = 500\,000\,\text{m}$. Solve the second (inverse) geodetic problem for the points A, C.

Grade ($24\,\text{p} = 100\%$)

$$\text{Grade} = 1 + 8 \times (\text{Exam} - 50\%) + 4 \times (\text{Exercises} - 50\%)$$

A minimum of 50% is required for both exam and exercises.