Exam: Introduction to Geodesy 22.10.2005

(Also qualifies as Fundamental Geodesy I) (Function calculator)

1. Fundamentals

- (a) What is a clothoid, and why is it being used for building railroads and motorways?
- (b) If in Peru the length of a degree of latitude is 110 km and in Lapland it is 112 km, calculate the *radius of curvature* of the Earth in both locations. Based on these numbers, is the Earth flattened or elongated?

2. Statistics, units

- (a) Explain random, gross and systematic errors.
- (b) Convert the angle $36^{\circ}45'30''$ to gon and radians.

3. Measurement instruments and methods

- (a) Explain how an automatic level works. Explanatory sketch.
- (b) Describe the axes and circles in an optical theodolite and the angles that are measured with a theodolite.

4. First and second geodetic problems

- (a) Given a point A: $x_A = 6\,700\,000$ m, $y_A = 500\,000$ m. The distance to point B is s = 2000 m and the azimuth (direction angle) t = 66.6666 gon. Solve the first (forward) geodetic problem for points A, B.
- (b) Given is also point C with coordinates $x_C = 6\,698\,267.9492\,\mathrm{m}, y_C = 499\,000\,\mathrm{m}$. Solve the second (inverse) geodetic problem for the points A, C

5. Helmert transformation

(a) Given the Helmert (similarity) transformation:

$$\begin{bmatrix} x^{(2)} \\ y^{(2)} \end{bmatrix} = (1+m) \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x^{(1)} \\ y^{(1)} \end{bmatrix} + \begin{bmatrix} \Delta x \\ \Delta y \end{bmatrix}.$$

Explain (in words only) what all transformation parameters $m, \theta, \Delta x, \Delta y$ mean.

(b) Given are points' A, B coordinates in the coordinate system (1):

$$x_A^{(1)} = 0 \text{ m}, y_A^{(1)} = 0 \text{ m}, x_B^{(1)} = 1000 \text{ m}, y_B^{(1)} = 1000 \text{ m};$$

and in the coordinate system (2):

$$x_A^{(2)} = 3500 \text{ m}; \ y_A^{(2)} = 1500 \text{ m}; \ x_B^{(2)} = 4502 \text{ m}; \ y_B^{(2)} = 2502 \text{ m}.$$

Assuming that the transformation between systems (1) and (2) is a Helmert transformation:

$$\begin{bmatrix} x^{(2)} \\ y^{(2)} \end{bmatrix} = (1+m) \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x^{(1)} \\ y^{(1)} \end{bmatrix} + \begin{bmatrix} \Delta x \\ \Delta y \end{bmatrix},$$

calculate its parameters $m, \theta, \Delta x$ and Δy .

Points:

Question	1 ab	2 a b	3 a b	4 a b	5 a b	Total.
Points	$\begin{array}{c}5\\2&3\end{array}$	$\frac{5}{3\ 2}$	$\begin{array}{c}5\\2&3\end{array}$	$\begin{array}{c}5\\2&3\end{array}$	$\begin{array}{c}5\\2&3\end{array}$	25

Points	10	13	16	19	23
Grade	1	2	3	4	5