Exam: Introduction to Geodesy 06.03.2010

(Function calculator)

1. **Fundamentals**

   (a) The flattening of the Earth. How does the internal distribution of the Earth's masses affect its flattening? Newton's and Huygens' ideas and modern understanding.

   (b) Describe the scientific controversy that the French Academy's grade measurement expeditions to Lapland and Peru attempted to settle, and how they did it.

   (c) What is a geodesic?

2. **Statistics, units**

   (a) Given
   $$\alpha = 57^\circ 35' 45''.$$
   Compute α also in radians and gons.

   (b) 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) The focusing of a measurement telecope. What is *parallax*?

   (b) Explain the self-levelling (automatic) level (drawing!).

4. **First and second geodetic problems**

   (a) Given a point A: $x_A = 6\,650\,000\,\mathrm{m}$, $y_A = 480\,000\,\mathrm{m}$. The distance to point B on $s = 2828.472\,\mathrm{m}$ and the azimuth (direction angle) $t = 50\,\mathrm{gon}$. Solve the first (forward) geodetic problem for points A, B.

   (b) Given is also point C with coordinates $x_C = 6\,649\,000\,\mathrm{m}$, $y_C = 479\,000\,\mathrm{m}$. Solve the second (inverse) geodetic problem for the points A, C .

5. **Helmert transformation**

   (a) Given are points' A, B coordinates in the coordinate system (1):
   $$x_A^{(1)} = 0\,\mathrm{m},\ y_A^{(1)} = 0\,\mathrm{m}, x_B^{(1)} = 2000\,\mathrm{m}, y_B^{(1)} = 1000\,\mathrm{m};$$
   and in the coordinate system (2):
   $$x_A^{(2)} = 3500\,\mathrm{m};\ y_A^{(2)} = 1500\,\mathrm{m};\ x_B^{(2)} = 5500.02\,\mathrm{m};\ y_B^{(2)} = 2500.01\,\mathrm{m}.$$
   Assuming that the transformation between systems (1) and (2) is a Helmert transformation:
   $$\begin{bmatrix} x^{(2)} \\ y^{(2)} \end{bmatrix} = K \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x^{(1)} \\ y^{(1)} \end{bmatrix} + \begin{bmatrix} \Delta x \\ \Delta y \end{bmatrix},$$
   calculate its parameters K, θ, Δx and Δy.

(b) What is the inverse matrix of

$$K \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$

? Is this matrix ever singular?

Points:

Question	1 a b c	2 a b	3 a b	4 a b	5 a b	Total
Points	5 2 2 1	5 2 3	5 2 3	5 2 3	5 2 3	25

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