Exercise 4: Propagation of observation errors - part II

- Propagation of variances and covariances -

Group:	Surname, First name:	Matriculation number:	Signature*:

* With my signature I declare that I was involved in the elaboration of this homework.

Submission until: **01.12.2023**

Objective

This exercise deals with the propagation of variances of uncorrelated observations for one or two unknown parameters.

Task 1:

The three sides $a = 3.00\,\mathrm{m}$, $b = 4.00\,\mathrm{m}$ and $c = 5.00\,\mathrm{m}$ of a triangle are determined with a standard deviation of $\sigma = 2\,\mathrm{cm}$.

- Calculate the area A of the triangle as well as the standard deviation s_A
  - Set up the functional relationship.
  - Create a flowchart for the design matrices.
    - Use the Heron´s formula to determine the area A:

$$A = \sqrt{s(s-a)(s-b)(s-c)}$$

where s is the semiperimeter of the triangle:

$$s = \frac{a+b+c}{2}$$

Task 2 (Homework):

The polar coordinates of two points, listed in Table 1, were obtained with a standard deviation of $\sigma_s = 0.001\,\mathrm{m}$ and $\sigma_t = 0.1\,\mathrm{gon}$. As a reminder Figure 1 gives you an overview about the relationship between polar and Cartesian coordinates.

Table 1: Measured polar coordinates

ID	Distance *s* [m]	Angle *t* [gon]
1	8.000	0.00
2	6.000	100.00

- Calculate the distance between the two points and its standard deviation.

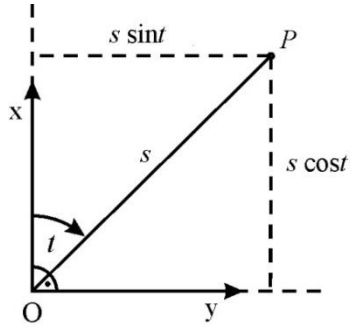

Figure 1: Polar vs. Cartesian coordinates

Task 3 (Homework):

Two huge water tanks are connected via a small pipe as depicted in Figure 2. At the moment no water can flow because the valve is closed. The radius r_i as well as the water level H_i for each water tank is given in Table 2 and they were obtained with a standard deviation of $\sigma_r = \sigma_H = 1\,\mathrm{cm}$. In order to reduce the pressure in water tank 2 the valve will be opened and water can flow from water tank 2 to water tank 1.

- Calculate the new amount of water at each water tank and their standard deviations.

Table 2: Measurements

Water tank	Radius r_i [m]	Water level H_i [m]
1	10.00	8.00
2	14.000	12.00

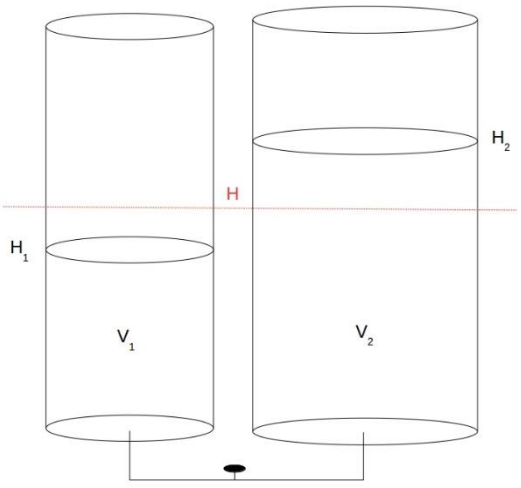

Figure 2: Water tanks