

December 2009 Technical Exams

04-Geom-A2, Adjustment of Observations & Data Analysis

(3 hours duration)

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a CLOSED BOOK EXAM. Any Sharp or Casio approved calculators are permitted.
3. FIVE (5) questions constitute a complete exam paper. The first five questions as they appear in the answer book will be marked.
4. Each question is of equal value.

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04-Geom-A2 Adjustment of Observations & Data Analysis

Candidate ID: _____ Name: _____ Signature: _____

Give answers to any five (5) of the following seven questions (100% total, 20 marks each).

1. A distance is measured five time with the following values obtained

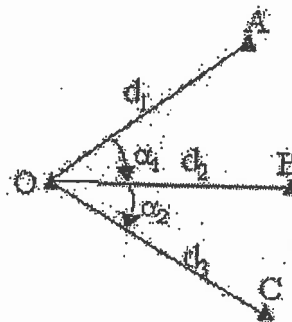
156.11 m	156.14 m	156.08 m	156.05 m	15.15 m
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The first two measurements have a standard deviation of 1 cm and the last three have a standard deviation of 2 cm. All measurements are uncorrelated. What is the weighted least-squares estimate of the distance? What is the standard deviation of the estimated distance?

2. The following figure shows a triangulation station O from which the horizontal directions d_1 , d_2 , and d_3 were measured to three stations A, B, and C, respectively, with the following observations:

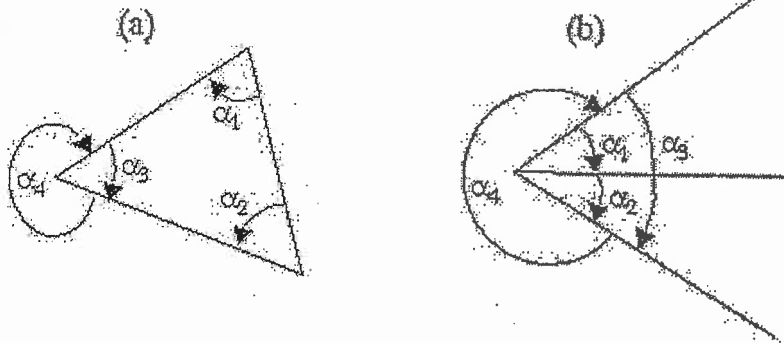
$$D_1 = 45^\circ 15' 25'', d_2 = 75^\circ 25' 35'', d_3 = 115^\circ 35' 45''$$

$$C_L = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{bmatrix} \text{arc sec}^2$$



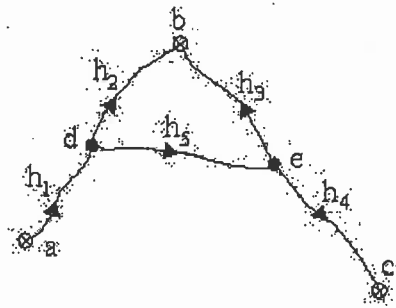
Calculate the estimates of the two horizontal angles α_1 and α_2 and their variance-covariance matrix. Discuss the degree of correlation between the two angles.

3. Write down in a matrix form the condition equations for the following triangulation networks.



4. Write down in a matrix form the indirect mathematical model for the following leveling network, where

$$L = \begin{bmatrix} h_1 \\ h_2 \\ h_3 \\ h_4 \\ h_5 \end{bmatrix}, X = \begin{bmatrix} h_d \\ h_e \end{bmatrix}, \text{ and points a, b, c, are benchmarks.}$$



5. If you have an Electronic Distance Measuring (DEM) device that has been calibrated to give a standard deviation for a single measurement = 15 mm, how many times should you measure a baseline of a length = 5 km, and whose relative error is specified not to exceed 2 ppm?

6. A leveling line which runs from a benchmark A of known elevation H_A to point B. The observed height differences h_1 and h_2 are to be observed with the same precision and uncorrelated. Calculate how many times should h_1 and h_2 be measured to have the standard deviation of the elevation point B not to exceed 3 mm? Assume that the standard deviation of a single height difference observation = 5 mm.

7. A network of differential levels is run from existing benchmark Juniper through new stations A and B to existing benchmarks Red and Rock as shown in the following figure. Develop the observation equations for adjusting this network by least-squares adjustment method, using the following elevation differences.

From	To	Elev. difference (m)	Distance (m)
Juniper	A	26.128	1000
A	B	6.873	2000
Red	B	11.552	800
Rock	B	-10.852	1200

