U N I V E R Z I T E T U N O V O M S A D U

FAKULTET TEHNIČKIH NAUKA

DEPARTMAN ZA GRAĐEVINARSTVO I GEODEZIJU

ELABORAT IZ PREDMETA

INŽENJERSKA GEODEZIJA 2

Jun, 2013. godine

OVERA:

Broj	Napomena:	Overa:
1.		
2.		
3.		
4.		
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13.		
14.		

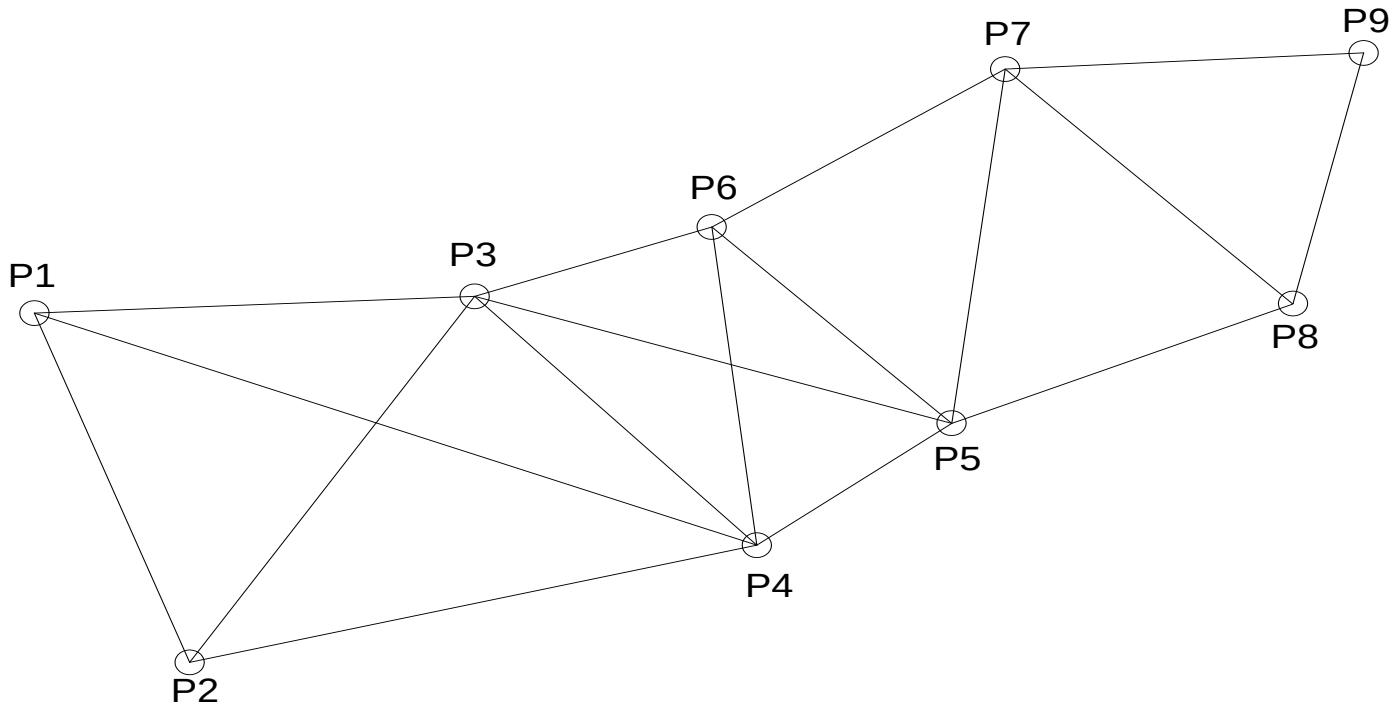
ZADATAK 1

a)

•Plan opažanja

Plan opažanja			
Stanica	Vizura	Pravac	Dužina
P1	P3	X	X
	P4	X	X
	P2	X	X
P2	P1	X	X
	P3	X	X
	P4	X	/
P3	P6	X	/
	P5	X	/
	P4	X	/
	P2	X	X
	P1	X	X
P4	P2	X	X
	P1	X	/
	P3	X	X
	P6	X	X
	P5	X	X
P5	P3	X	/
	P7	X	X
	P8	X	/
P6	P7	X	X
	P5	X	X
P7	P6	X	/
	P9	X	X
	P8	X	X
P8	P5	X	X
	P7	X	X
	P9	X	X

•Skica mreže



• Jednačine popravaka za pravce

$$v_{\alpha_{p1-p3}} = a_{p1p3}\,\Delta\,x_{p1p3} + b_{p1p3}\,\Delta\,y_{p1p3} + c_{p1p3}\,\Delta\,z_1 + f_{\alpha_{p1-p3}}$$

$$v_{\alpha_{p1-p4}} = a_{p1p4}\,\Delta\,x_{p1p4} + b_{p1p4}\,\Delta\,y_{p1p4} + c_{p1p4}\,\Delta\,z_1 + f_{\alpha_{p1-p4}}$$

$$v_{\alpha_{p1-p2}} = a_{p1p2}\,\Delta\,x_{p1p2} + b_{p1p2}\,\Delta\,y_{p1p2} + c_{p1p2}\,\Delta\,z_1 + f_{\alpha_{p1-p2}}$$

$$v_{\alpha_{p2-p1}} = a_{p2p1}\,\Delta\,x_{p2p1} + b_{p2p1}\,\Delta\,y_{p2p1} + c_{p2p1}\,\Delta\,z_2 + f_{\alpha_{p2-p1}}$$

$$v_{\alpha_{p2-p3}} = a_{p2p3}\,\Delta\,x_{p2p3} + b_{p2p3}\,\Delta\,y_{p2p3} + c_{p2p3}\,\Delta\,z_2 + f_{\alpha_{p2-p3}}$$

$$v_{\alpha_{p2-p4}} = a_{p2p4}\,\Delta\,x_{p2p4} + b_{p2p4}\,\Delta\,y_{p2p4} + c_{p2p4}\,\Delta\,z_2 + f_{\alpha_{p2-p4}}$$

$$v_{\alpha_{p3-p6}} = a_{p3p6}\,\Delta\,x_{p3p6} + b_{p3p6}\,\Delta\,y_{p3p6} + c_{p3p6}\,\Delta\,z_3 + f_{\alpha_{p3-p6}}$$

$$v_{\alpha_{p3-p5}} = a_{p3p5}\,\Delta\,x_{p3p5} + b_{p3p5}\,\Delta\,y_{p3p5} + c_{p3p5}\,\Delta\,z_3 + f_{\alpha_{p3-p5}}$$

$$v_{\alpha_{p3-p4}} = a_{p3p4}\,\Delta\,x_{p3p4} + b_{p3p4}\,\Delta\,y_{p3p4} + c_{p3p4}\,\Delta\,z_3 + f_{\alpha_{p3-p4}}$$

$$v_{\alpha_{p3-p2}} = a_{p3p2}\,\Delta\,x_{p3p2} + b_{p3p2}\,\Delta\,y_{p3p2} + c_{p3p2}\,\Delta\,z_3 + f_{\alpha_{p3-p2}}$$

$$v_{\alpha_{p3-p1}} = a_{p3p1}\,\Delta\,x_{p3p1} + b_{p3p1}\,\Delta\,y_{p3p1} + c_{p3p1}\,\Delta\,z_3 + f_{\alpha_{p3-p1}}$$

$$v_{\alpha_{p4-p2}} = a_{p4p2}\,\Delta\,x_{p4p2} + b_{p4p2}\,\Delta\,y_{p4p2} + c_{p4p2}\,\Delta\,z_4 + f_{\alpha_{p4-p2}}$$

$$v_{\alpha_{p4-p1}} = a_{p4p1}\,\Delta\,x_{p4p1} + b_{p4p1}\,\Delta\,y_{p4p1} + c_{p4p1}\,\Delta\,z_4 + f_{\alpha_{p4-p1}}$$

$$v_{\alpha_{p4-p3}} = a_{p4p3}\,\Delta\,x_{p4p3} + b_{p4p3}\,\Delta\,y_{p4p3} + c_{p4p3}\,\Delta\,z_4 + f_{\alpha_{p4-p3}}$$

$$v_{\alpha_{p4-p6}} = a_{p4p6}\,\Delta\,x_{p4p6} + b_{p4p6}\,\Delta\,y_{p4p6} + c_{p4p6}\,\Delta\,z_4 + f_{\alpha_{p4-p6}}$$

$$v_{\alpha_{p4-p5}} = a_{p4p5}\,\Delta\,x_{p4p5} + b_{p4p5}\,\Delta\,y_{p4p5} + c_{p4p5}\,\Delta\,z_4 + f_{\alpha_{p4-p5}}$$

$$v_{\alpha_{p5-p3}} = a_{p5p3}\,\Delta\,x_{p5p3} + b_{p5p3}\,\Delta\,y_{p5p3} + c_{p5p3}\,\Delta\,z_5 + f_{\alpha_{p5-p3}}$$

$$v_{\alpha_{p5-p7}} = a_{p5p7}\,\Delta\,x_{p5p7} + b_{p5p7}\,\Delta\,y_{p5p7} + c_{p5p7}\,\Delta\,z_5 + f_{\alpha_{p5-p7}}$$

$$v_{\alpha_{p5-p8}} = a_{p5p8}\,\Delta\,x_{p5p8} + b_{p5p8}\,\Delta\,y_{p5p8} + c_{p5p8}\,\Delta\,z_5 + f_{\alpha_{p5-p8}}$$

$$v_{\alpha_{p6-p7}} = a_{p6p7}\,\Delta\,x_{p6p7} + b_{p6p7}\,\Delta\,y_{p6p7} + c_{p6p7}\,\Delta\,z_6 + f_{\alpha_{p6-p7}}$$

$$v_{\alpha_{p6-p5}} = a_{p6p5}\,\Delta\,x_{p6p5} + b_{p6p5}\,\Delta\,y_{p6p5} + c_{p6p5}\,\Delta\,z_6 + f_{\alpha_{p6-p5}}$$

$$v_{\alpha_{p7-p6}} = a_{p7p6}\,\Delta\,x_{p7p6} + b_{p7p6}\,\Delta\,y_{p7p6} + c_{p7p6}\,\Delta\,z_7 + f_{\alpha_{p7-p6}}$$

$$v_{\alpha_{p7-p9}} = a_{p7p9}\,\Delta\,x_{p7p9} + b_{p7p9}\,\Delta\,y_{p7p9} + c_{p7p9}\,\Delta\,z_7 + f_{\alpha_{p7-p9}}$$

$$v_{\alpha_{p7-p8}} = a_{p7p8} \Delta x_{p7p8} + b_{p7p8} \Delta y_{p7p8} + c_{p7p8} \Delta z_7 + f_{\alpha_{p7-p8}}$$

$$v_{\alpha_{p8-p5}} = a_{p8p5} \Delta x_{p8p5} + b_{p8p5} \Delta y_{p8p5} + c_{p8p5} \Delta z_8 + f_{\alpha_{p8-p5}}$$

$$v_{\alpha_{p8-p7}} = a_{p8p7} \Delta x_{p8p7} + b_{p8p7} \Delta y_{p8p7} + c_{p8p7} \Delta z_8 + f_{\alpha_{p8-p7}}$$

$$v_{\alpha_{p8-p9}} = a_{p8p9} \Delta x_{p8p9} + b_{p8p9} \Delta y_{p8p9} + c_{p8p9} \Delta z_8 + f_{\alpha_{p8-p9}}$$

$$a_{ij} = \frac{\rho'' \sin \nu_i^j}{D_{i-j}^0} \qquad b_{ij} = -\frac{\rho'' \cos \nu_i^j}{D_{i-j}^0} \qquad c_{ij} = 1$$

• Jednačine popravaka za dužine

$$v_{d_{p1-p3}} = A_{p1p3} \Delta x_{p1p3} + B_{p1p3} \Delta y_{p1p3} + f_{d_{p1-p3}}$$

$$v_{d_{p1-p4}} = A_{p1p4} \Delta x_{p1p4} + B_{p1p4} \Delta y_{p1p4} + f_{d_{p1-p4}}$$

$$v_{d_{p1-p2}} = A_{p1p2} \Delta x_{p1p2} + B_{p1p2} \Delta y_{p1p2} + f_{d_{p1-p2}}$$

$$v_{d_{p2-p1}} = A_{p2p1} \Delta x_{p2p1} + B_{p2p1} \Delta y_{p2p1} + f_{d_{p2-p1}}$$

$$v_{d_{p2-p3}} = A_{p2p3} \Delta x_{p2p3} + B_{p2p3} \Delta y_{p1p3} + f_{d_{p2-p3}}$$

$$v_{d_{p3-p2}} = A_{p3p2} \Delta x_{p3p2} + B_{p3p2} \Delta y_{p3p2} + f_{d_{p3-p2}}$$

$$v_{d_{p3-p1}} = A_{p3p1} \Delta x_{p3p1} + B_{p3p1} \Delta y_{p3p1} + f_{d_{p3-p1}}$$

$$v_{d_{p4-p2}} = A_{p4p2} \Delta x_{p4p2} + B_{p4p2} \Delta y_{p4p2} + f_{d_{p4-p2}}$$

$$v_{d_{p4-p3}} = A_{p4p3} \Delta x_{p4p3} + B_{p4p3} \Delta y_{p4p3} + f_{d_{p4-p3}}$$

$$v_{d_{p4-p6}} = A_{p4p6} \Delta x_{p4p6} + B_{p4p6} \Delta y_{p4p6} + f_{d_{p4-p6}}$$

$$v_{d_{p4-p5}} = A_{p4p5} \Delta x_{p4p5} + B_{p4p5} \Delta y_{p4p5} + f_{d_{p4-p5}}$$

$$v_{d_{p5-p7}} = A_{p5p7} \Delta x_{p5p7} + B_{p5p7} \Delta y_{p5p7} + f_{d_{p5-p7}}$$

$$v_{d_{p6-p7}} = A_{p6p7} \Delta x_{p6p7} + B_{p6p7} \Delta y_{p6p7} + f_{d_{p6-p7}}$$

$$v_{d_{p6-p5}} = A_{p6p5} \Delta x_{p6p5} + B_{p6p5} \Delta y_{p6p5} + f_{d_{p6-p5}}$$

$$v_{d_{p7-p9}} = A_{p7p9} \Delta x_{p7p9} + B_{p7p9} \Delta y_{p7p9} + f_{d_{p7-p9}}$$

$$v_{d_{p7-p8}} = A_{p7p8} \Delta x_{p7p8} + B_{p7p8} \Delta y_{p7p8} + f_{d_{p7-p8}}$$

$$v_{d_{p8-p5}} = A_{p8p5} \Delta x_{p8p5} + B_{p8p5} \Delta y_{p8p5} + f_{d_{p8-p5}}$$

$$v_{d_{p8-p7}} = A_{p8p7} \Delta x_{p8p7} + B_{p8p7} \Delta y_{p8p7} + f_{d_{p8-p7}}$$

$$v_{d_{p8-p9}} = A_{p8p9} \Delta x_{p8p9} + B_{p8p9} \Delta y_{p8p9} + f_{d_{p8-p9}}$$

$$A_{ij} = -\sin \nu_i^j \qquad B_{ij} = -\cos \nu_i^j$$

•Homogenizacija težina

Standarno odstupanje pravca je $\sigma_{\alpha_{i-j}} = 1"$.

Pravci su mereni u dva girusa.Dužine su merene u dva ponavljanja.

$$\sigma_{\alpha_i} = \frac{\sigma_{\alpha_{i-j}}}{\sqrt{2}} = \frac{1}{\sqrt{2}} = 0.7071"$$

$P_{\alpha_{i-j}} = \frac{\sigma_0^2}{\sigma_{\alpha_{i-j}}^2} = \frac{c}{\sigma_{\alpha_i - j}^2}$, $\sigma_0^2 = 0.7071^2 = 0.5$ $\quad P_{d_{i-j}} = \frac{\sigma_0^2}{\sigma_{d_{i-j}}^2} = \frac{c}{\sigma_{d_{i-j}}^2}$, $\sigma_{d_{i-j}} = \frac{1mm+1ppm}{\sqrt{2}}$

$P_{\alpha_{i-j}} = 1$

$\sigma_{d_{p1-p3}} = 0.8504\ mm$ $\quad \sigma_{d_{p5-p7}} = 0.8439\ mm$

$\sigma_{d_{p1-p4}} = 0.9582\ mm$ $\quad \sigma_{d_{p6-p7}} = 0.8201\ mm$

$\sigma_{d_{p1-p2}} = 0.8502\ mm$ $\quad \sigma_{d_{p6-p5}} = 0.8154\ mm$

$\sigma_{d_{p2-p1}} = 0.8502\ mm$ $\quad \sigma_{d_{p7-p9}} = 0.8238\ mm$

$\sigma_{d_{p2-p3}} = 0.8752\ mm$ $\quad \sigma_{d_{p7-p8}} = 0.8368\ mm$

$\sigma_{d_{p3-p2}} = 0.8752\ mm$ $\quad \sigma_{d_{p8-p5}} = 0.8272\ mm$

$\sigma_{d_{p3-p1}} = 0.8504\ mm$ $\quad \sigma_{d_{p8-p7}} = 0.8368\ mm$

$\sigma_{d_{p4-p2}} = 0.8969\ mm$ $\quad \sigma_{d_{p8-p9}} = 0.8059\ mm$

$\sigma_{d_{p4-p3}} = 0.8394\ mm$ $\quad \sigma_{d_{p4-p5}} = 0.7858\ mm$

$\sigma_{d_{p4-p6}} = 0.8299\ mm$

•Matrica dizajna A

$A =$

X1	Y1	X2	Y2	X3	Y3	X4	Y4	X5	Y5	X6	Y6	X7	Y7	X8	Y8	X9	Y9	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8
1,017111	-0,04561188	0	0	-1,01711	0,045611884	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0,543159	0,205687647	0	0	0	0	-0,54316	-0,20569	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0,359612	0,954046814	-0,35961	-0,95405	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0,359612	0,954046814	-0,35961	-0,95405	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0,478158	-0,72392	-0,47816	0,723916463	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0,746669	-0,18192	0	0	-0,74667	0,181917	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	1,691358	-0,58358988	0	0	0	0	-1,691358379	0,58359	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0,856612	0,268485924	0	0	-0,856612	-0,26849	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0,76424	0,794354102	-0,76424	-0,79435	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0,478158	-0,72392	-0,47816	0,723916463	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
1,017111	-0,04561188	0	0	-1,01711	0,045611884	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0,746669	-0,18192	0	0	-0,74667	0,181917	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0,543159	0,205687647	0	0	0	0	-0,54316	-0,20569	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0,76424	0,794354102	-0,76424	-0,79435	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	-0,14191	-1,17901	0	0	0,141912895	1,179011	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	1,49072	-1,1012	-1,49072	1,101196	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0,856612	0,268485924	0	0	-0,856612	-0,26849	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0,135826	-1,05743	0	0	-0,13583	1,057427	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	1,122508	-0,46358	0	0	0	0	-1,12251	0,463576	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	1,090197883	-0,69145	-1,0902	0,691454	0	0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	-0,969356	-0,93461	0,969355544	0,934607	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	1,090197883	-0,69145	-1,0902	0,691454	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	1,248107	-0,06631	0	0	-1,24811	-1,24811	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0,810971	0,778711	-0,81097	-0,77871	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1,122508	-0,46358	0	0	0	0	-1,12251	0,463576	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0,810971	0,778711	-0,81097	-0,77871	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,343381	-1,43655	-0,34338	1,436552	0	0	0	0	0	0	0	1
-0,0448	-0,998996	0	0	0,0448	0,998995997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0,354145	-0,93519038	0	0	0	0	-0,35415	0,93519	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0,935733	-0,35270904	-0,93573	0,352709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0,935733	-0,35270904	-0,93573	0,352709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	-0,83441	-0,55114	0,834412	0,551141606	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	-0,83441	-0,55114	0,834412	0,551141606	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0,0448	-0,998996	0	0	0,0448	0,998995997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	-0,23671	0,746669	0	0	0,236714	0,971579	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0,720634	-0,69331535	-0,72063	0,693315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-0,99283	0,119503	0	0	0,992833785	-0,1195	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-0,59417	-0,80434	0,594167	0,804341	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	-0,991851	-0,1274	0	0	0,991851	0,127402	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	-0,535602013	-0,84447	0,535602	0,844471	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	-0,694086	0,719892	0,694086157	-0,71989	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-0,05306	-0,99859	0	0	0,053057	0,721308	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0,692615	-0,72131	-0,69261	0,721308	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	-0,381712	-0,92428	0	0	0	0	0,381712	0,924281	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0,692615	-0,72131	-0,69261	0,721308	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0,9726	-0,23248	0,972601	0,232482	0	0	0	0	0	0	0	0

•Matrica težina P

$$P_{diag} = [\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1$$

$$0.691\ \ 0.545\ \ 0.692\ \ \ 0.692\ \ \ 0.653\ \ 0.653\ \ 0.691\ \ 0.622\ \ 0.710\ \ 0.726$$

$$0.810\ \ 0.702\ \ 0.743\ \ 0.752\ \ 0.737\ \ 0.714\ \ 0.731\ \ 0.714\ \ 0.770\ ]$$

•Matrica koeficijenata normalnih jednačina N $\quad N = A^T PA$

$N =$

4,200231	0,241738832	-1,47009	-0,22954	-2,0718	0,030893178	-0,65834	-0,04309	0	0	0	0	0	0	0	0	0	0	1,919882	0,359612	1,017111	0,543159	0	0	0	0
0,241739	3,937688153	-0,22954	-1,99253	0,030893	-1,38429504	-0,04309	-0,56086	0	0	0	0	0	0	0	0	0	0	1,114123	0,954047	-0,04561	0,205688	0	0	0	0
-1,47009	-0,22953895	3,986136	-0,24392	-1,36619	0,091936571	-1,14986	0,128711	0	0	0	0	0	0	0	0	0	0	-0,35961	0,865214	0,478158	0,746669	0	0	0	0
-0,22954	-1,99253149	-0,24392	3,849908	0,091937	-1,44465437	0,381524	0,384729	0	0	0	0	0	0	0	0	0	0	-0,95405	-1,85988	-0,72392	-0,18192	0	0	0	0
-2,0718	0,030893178	-1,36619	0,091937	9,302883	0,209710641	-1,53663	-0,85962	-1,467567	-0,45998	-2,860693165	0,98706	0	0	0	0	0	0	-1,01711	-0,47816	1,816942	0,76424	0,856612	0	0	0
0,030893	-1,38429504	0,091937	-1,44465	0,209711	4,916783963	-0,85962	-1,60309	-0,459976	-0,14417	0,98705963	-0,34058	0	0	0	0	0	0	0,045612	0,723916	1,248778	0,794354	0,268486	0	0	0
-0,65834	-0,04309306	-1,14986	0,381524	-1,53663	-0,85962375	6,588628	-0,3994	-2,50811	1,254591	-0,735695106	-0,08119	0	0	0	0	0	0	-0,54316	-0,74667	-0,76424	-0,70526	0	0	0	0
-0,04309	-0,56086163	0,128711	0,384729	-0,85962	-1,60308803	-0,3994	5,953815	1,254591	-1,7365	-0,081188294	-1,40043	0	0	0	0	0	0	-0,20569	0,181917	-0,79435	-3,09833	0	0	0	0
0	0	0	0	-1,46757	-0,45997627	-2,50811	1,254591	8,613226	-1,10223	-1,301918625	-0,53023	-0,70911	0,05491	-2,62652	0,782934	0	0	0	0	-0,85661	-1,49072	0,401722	-0,96936	0	1,122508
0	0	0	0	-0,45998	-0,14416938	1,254591	-1,7365	-1,10223	5,327467	-0,530229349	-1,2632	0,05491	-1,12955	0,782934	-1,05405	0	0	0	0	-0,26849	1,101196	-1,78949	-0,93461	0	-0,46358
0	0	0	0	-2,86069	0,98705963	-0,7357	-0,08119	-1,301919	-0,53023	7,488643813	-1,54702	-2,59034	1,171378	0	0	0	0	0	0	-1,69136	0,141913	0	2,059553	1,090198	0
0	0	0	0	0,98706	-0,34057715	-0,08119	-1,40043	-0,530229	-1,2632	-1,547020483	4,490605	1,171378	-1,4864	0	0	0	0	0	0	0,58359	1,179011	0	0,243154	-0,69145	0
0	0	0	0	0	0	0	0	-0,709113	0,05491	-2,590336917	1,171378	6,859668	-0,7204	-2,00037	-0,54962	-1,55985	-1,58597	0	0	0	0	-0,13583	-1,0902	0,96888	0,810971
0	0	0	0	0	0	0	0	0,05491	-1,12955	1,171378495	-1,4864	-0,7204	5,310765	-0,54962	-1,95574	0,043732	-0,44791	0	0	0	0	1,057427	0,691454	1,40385	0,778711
0	0	0	0	0	0	0	0	-2,626518	0,782934	0	0	-2,00037	-0,54962	5,473127	-0,55251	-0,84624	0,319192	0	0	0	0	-1,12251	0	-0,81097	-1,5901
0	0	0	0	0	0	0	0	0,782934	-1,05405	0	0	-0,54962	-1,95574	-0,55251	5,115085	0,319192	-2,10529	0	0	0	0	0,463576	0	-0,77871	-1,75169
0	0	0	0	0	0	0	0	0	0	0	0	-1,55985	0,043732	-0,84624	0,319192	2,406084	1,266776	0	0	0	0	0	0	-1,24811	-0,34338
0	0	0	0	0	0	0	0	0	0	0	0	-1,58597	-0,44791	0,319192	-2,10529	1,266776	4,046392	0	0	0	0	0	0	-1,24811	1,436552
1,919882	1,114122578	-0,35961	-0,95405	-1,01711	0,045611884	-0,54316	-0,20569	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
0,359612	0,954046814	0,865214	-1,85988	-0,47816	0,723916463	-0,74667	0,181917	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
1,017111	-0,04561188	0,478158	-0,72392	1,816942	1,248778494	-0,76424	-0,79435	-0,856612	-0,26849	-1,691358379	0,58359	0	0	0	0	0	0	0	0	5	0	0	0	0	0
0,543159	0,205687647	0,746669	-0,18192	0,76424	0,794354102	-0,70526	-3,09833	-1,49072	1,101196	0,141912895	1,179011	0	0	0	0	0	0	0	0	0	5	0	0	0	0
0	0	0	0	0,856612	0,268485924	0	0	0,401722	-1,78949	0	0	-0,13583	1,057427	-1,12251	0,463576	0	0	0	0	0	0	3	0	0	0
0	0	0	0	0	0	0	0	-0,969356	-0,93461	2,059553427	0,243154	-1,0902	0,691454	0	0	0	0	0	0	0	0	0	2	0	0
0	0	0	0	0	0	0	0	0	0	0	1,090197883	-0,69145	0,96888	1,40385	-0,81097	-0,77871	-1,24811	-1,24811	0	0	0	0	0	3	0
0	0	0	0	0	0	0	0	1,122508	-0,46358	0	0	0,810971	0,778711	-1,5901	-1,75169	-0,34338	1,436552	0	0	0	0	0	0	0	3

•Matrica datumskih uslova R

Datum je definisan na klsičan način koordinatam tačaka $Y_8,\ X_8\ i\ Y_9$.

$R^T =$

X1	Y1	X2	Y2	X3	Y3	X4	Y4	X5	Y5	X6	Y6	X7	Y7	X8	Y8	X9	Y9	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

•Matrica koeficijenata normalnih jednačina N proširena matricom datumskih uslova R $N = N + RR^T$ $\begin{bmatrix} N & R \\ R^T & 0 \end{bmatrix}$

$\begin{bmatrix} N & R \\ R^T & 0 \end{bmatrix} =$

4,200231	0,24174	-1,470088177	-0,22954	-2,0718	0,030893178	-0,658	-0,04309	0	0	0	0	0	0	0	0	0	0	1,92	0,359612	1,017111	0,543159	0	0	0	0	0	0	0
0,241739	3,93769	-0,229538947	-1,99253	0,03089	-1,38429504	-0,043	-0,56086	0	0	0	0	0	0	0	0	0	0	1,11	0,954047	-0,04561	0,205688	0	0	0	0	0	0	0
-1,47009	-0,2295	3,986135523	-0,24392	-1,3662	0,091936571	-1,15	0,128711	0	0	0	0	0	0	0	0	0	0	-0,4	0,865214	0,478158	0,746669	0	0	0	0	0	0	0
-0,22954	-1,9925	-0,243921336	3,849908	0,09194	-1,44465437	0,3815	0,384729	0	0	0	0	0	0	0	0	0	0	-1	-1,85988	-0,72392	-0,18192	0	0	0	0	0	0	0
-2,0718	0,03089	-1,366190681	0,091937	9,30288	0,209710641	-1,537	-0,85962	-1,4676	-0,45998	-2,860693165	0,98706	0	0	0	0	0	0	-1	-0,47816	1,816942	0,76424	0,856612	0	0	0	0	0	0
0,030893	-1,3843	0,091936571	-1,44465	0,20971	4,916783963	-0,86	-1,60309	-0,46	-0,14417	0,98705963	-0,3406	0	0	0	0	0	0	0,05	0,723916	1,248778	0,794354	0,268486	0	0	0	0	0	0
-0,65834	-0,0431	-1,149856665	0,381524	-1,5366	-0,85962375	6,5886	-0,3994	-2,5081	1,254591	-0,735695106	-0,0812	0	0	0	0	0	0	-0,5	-0,74667	-0,76424	-0,70526	0	0	0	0	0	0	0
-0,04309	-0,5609	0,12871063	0,384729	-0,8596	-1,60308803	-0,399	5,953815	1,2546	-1,7365	-0,081188294	-1,4004	0	0	0	0	0	0	-0,2	0,181917	-0,79435	-3,09833	0	0	0	0	0	0	0
0	0	0	0	-1,4676	-0,45997627	-2,508	1,254591	8,6132	-1,10223	-1,301918625	-0,5302	-0,7091	0,05491	-2,62652	0,782934	0	0	0	0	-0,85661	-1,49072	0,401722	-0,96936	0	1,122508	0	0	0
0	0	0	0	-0,46	-0,14416938	1,2546	-1,7365	-1,1022	5,327467	-0,530229349	-1,2632	0,05491	-1,12955	0,782934	-1,05405	0	0	0	0	-0,26849	1,101196	-1,78949	-0,93461	0	-0,46358	0	0	0
0	0	0	0	-2,8607	0,98705963	-0,736	-0,08119	-1,3019	-0,53023	7,488643813	-1,547	-2,5903	1,171378	0	0	0	0	0	0	-1,69136	0,141913	0	2,059553	1,090198	0	0	0	0
0	0	0	0	0,98706	-0,34057715	-0,081	-1,40043	-0,5302	-1,2632	-1,547020483	4,4906	1,17138	-1,4864	0	0	0	0	0	0	0,58359	1,179011	0	0,243154	-0,69145	0	0	0	0
0	0	0	0	0	0	0	0	-0,7091	0,05491	-2,590336917	1,17138	6,85967	-0,7204	-2,00037	-0,54962	-1,55985	-1,58597	0	0	0	0	-0,13583	-1,0902	0,96888	0,810971	0	0	0
0	0	0	0	0	0	0	0	0,0549	-1,12955	1,171378495	-1,4864	-0,7204	5,310765	-0,54962	-1,95574	0,043732	-0,44791	0	0	0	0	1,057427	0,691454	1,40385	0,778711	0	0	0
0	0	0	0	0	0	0	0	-2,6265	0,782934	0	0	-2,0004	-0,54962	5,473127	-0,55251	-0,84624	0,319192	0	0	0	0	-1,12251	0	-0,81097	-1,5901	1	0	0
0	0	0	0	0	0	0	0	0,7829	-1,05405	0	0	-0,5496	-1,95574	-0,55251	5,115085	0,319192	-2,10529	0	0	0	0	0,463576	0	-0,77871	-1,75169	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	-1,5598	0,043732	-0,84624	0,319192	2,406084	1,266776	0	0	0	0	0	0	-1,24811	-0,34338	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0	-1,586	-0,44791	0,319192	-2,10529	1,266776	4,046392	0	0	0	0	0	0	-1,24811	1,436552	0	0	0
1,919882	1,11412	-0,359612108	-0,95405	-1,0171	0,045611884	-0,543	-0,20569	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
0,359612	0,95405	0,865214295	-1,85988	-0,4782	0,723916463	-0,747	0,181917	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
1,017111	-0,0456	0,478157808	-0,72392	1,81694	1,248778494	-0,764	-0,79435	-0,8566	-0,26849	-1,691358379	0,58359	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
0,543159	0,20569	0,746668595	-0,18192	0,76424	0,794354102	-0,705	-3,09833	-1,4907	1,101196	0,141912895	1,17901	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
0	0	0	0	0,85661	0,268485924	0	0	0,4017	-1,78949	0	0	-0,1358	1,057427	-1,12251	0,463576	0	0	0	0	0	0	3	0	0	0	0	0	0
0	0	0	0	0	0	0	0	-0,9694	-0,93461	2,059553427	0,24315	-1,0902	0,691454	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1,090197883	-0,6915	0,96888	1,40385	-0,81097	-0,77871	-1,24811	-1,24811	0	0	0	0	0	0	3	0	0	0	0
0	0	0	0	0	0	0	0	1,1225	-0,46358	0	0	0,81097	0,778711	-1,5901	-1,75169	-0,34338	1,436552	0	0	0	0	0	0	0	3	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

•Matrica kofaktora nepoznatih parametara $N^- = Q_x$ $N^- = (N + RR^T)^{-1} - RR^T$ $\begin{bmatrix} N^- & R^- \\ R^{T-} & 0^- \end{bmatrix}$

$N^- =$

8,467239	1,663869351	7,256237	-0,62265	5,475942	1,687830301	3,921921	-0,2714	2,481427	-0,1135	3,711489126	1,261269	2,067192	1,552843	0	0	0	1,286988	-2,84247	-2,56478	-2,81911	-2,45256	-2,56837	-2,23573	-1,91689	-2,52417
1,663869	1,158498938	1,441366	0,337312	0,930773	0,89136104	0,63185	0,187957	0,37505	0,194609	0,461855688	0,451504	0,237511	0,325714	0	0	0	0,18635	-0,7857	-0,69532	-0,67308	-0,56028	-0,38373	-0,24092	-0,21537	-0,34824
7,256237	1,441365649	6,628279	-0,47533	4,905045	1,467861374	3,584453	-0,22482	2,280267	-0,12318	3,40125698	1,10864	1,904684	1,399337	0	0	0	1,181026	-2,26138	-2,20114	-2,39731	-2,12229	-2,31776	-2,03523	-1,7591	-2,31588
-0,62265	0,337311506	-0,47533	0,834731	-0,34031	0,260595993	-0,17103	0,185947	-0,089489	0,099949	-0,230662558	0,021267	-0,11695	-0,04863	0	0	0	-0,05453	0,344128	0,450988	0,267556	0,209671	0,157296	0,19134	0,126565	0,119278
5,475942	0,930773423	4,905045	-0,34031	3,992794	0,971133814	2,942021	-0,15044	1,937945	-0,16105	2,915529883	0,798242	1,652754	1,129871	0	0	0	1,003439	-1,50902	-1,43461	-1,67505	-1,47857	-1,906	-1,72508	-1,52055	-1,97056
1,68783	0,89136104	1,467861	0,260596	0,971134	1,03116864	0,676952	0,205481	0,398367	0,200134	0,451412663	0,475471	0,239303	0,341405	0	0	0	0,196729	-0,70212	-0,68558	-0,73598	-0,56942	-0,41305	-0,22365	-0,20965	-0,36564
3,921921	0,631849729	3,584453	-0,17103	2,942021	0,676952201	2,45939	-0,06511	1,585689	-0,20281	2,296834343	0,552166	1,335541	0,856519	0	0	0	0,815582	-0,94127	-0,88924	-1,05891	-0,92218	-1,47538	-1,3267	-1,20023	-1,59855
-0,2714	0,187957171	-0,22482	0,185947	-0,15044	0,205481085	-0,06511	0,458443	-0,028748	0,22798	-0,077661481	0,180273	-0,06435	0,036076	0	0	0	-0,0252	0,101578	0,035308	0,131579	0,22825	0,148777	0,10311	0,063189	0,066082
2,481427	0,375050178	2,280267	-0,08949	1,937945	0,398367064	1,585689	-0,02875	1,220234	-0,07675	1,585466343	0,368061	0,978749	0,597561	0	0	0	0,612487	-0,54632	-0,52068	-0,60001	-0,5335	-0,9645	-0,79495	-0,83223	-1,18141
-0,1135	0,194608795	-0,12318	0,099949	-0,16105	0,200133795	-0,20281	0,22798	-0,076748	0,530514	-0,160626088	0,270261	-0,11273	0,052765	0	0	0	-0,06095	-0,06135	-0,08906	-0,00567	-0,06705	0,331099	0,263575	0,107021	0,156656
3,711489	0,461855688	3,401257	-0,23066	2,91553	0,451412663	2,296834	-0,07766	1,585466	-0,16063	2,615810174	0,59901	1,437171	0,89492	0	0	0	0,825476	-0,82024	-0,78358	-0,86499	-0,88742	-1,43138	-1,59914	-1,35202	-1,63413
1,261269	0,451503917	1,10864	0,021267	0,798242	0,475470852	0,552166	0,180273	0,368061	0,270261	0,599009765	0,712037	0,226722	0,389565	0	0	0	0,182952	-0,45945	-0,46234	-0,45409	-0,46301	-0,2856	-0,40983	-0,23297	-0,34597
2,067192	0,237510836	1,904684	-0,11695	1,652754	0,239303138	1,335541	-0,06435	0,978749	-0,11273	1,437170565	0,226722	1,074801	0,545082	0	0	0	0,627731	-0,42591	-0,40317	-0,46255	-0,44277	-0,83511	-0,68841	-0,81104	-1,11626
1,552843	0,325713546	1,399337	-0,04863	1,129871	0,341404964	0,856519	0,036076	0,597561	0,052765	0,894920453	0,389565	0,545082	0,662004	0	0	0	0,362356	-0,42702	-0,41475	-0,45051	-0,42732	-0,61038	-0,5864	-0,5705	-0,70814
2,36E-16	2,95118E-17	-1,2E-16	1,48E-17	-2,4E-16	0	0	1,84E-17	-5,9E-17	5,9E-17	-1,18047E-16	-5,9E-17	-1,8E-16	-1,2E-16	0	0	0	-1,2E-16	2,95E-17	-1,8E-16	-3E-17	-3E-17	-5,9E-17	5,9E-17	-5,9E-17	1,18E-16
-5E-16	-2,8501E-16	-2E-16	-5E-17	-1,4E-16	-1,5485E-16	4,49E-17	-1,7E-18	5,83E-17	-2,1E-16	1,25674E-16	1,91E-16	-1,7E-16	1,3E-16	0	0	0	5,39E-17	1,03E-16	-4,5E-18	1,53E-16	-8,1E-17	-1,1E-16	-5,8E-17	-1,1E-16	1,17E-16
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,286988	0,186349503	1,181026	-0,05453	1,003439	0,196728619	0,815582	-0,0252	0,612487	-0,06095	0,825476138	0,182952	0,627731	0,362356	0	0	0	0,737191	-0,28545	-0,27097	-0,31451	-0,28156	-0,5218	-0,38702	-0,32341	-0,85534
-2,84247	-0,78570006	-2,26138	0,344128	-1,50902	-0,70212122	-0,94127	0,101578	-0,54632	-0,06135	-0,820238137	-0,45945	-0,42591	-0,42702	0	0	0	-0,28545	1,618161	1,14461	1,112393	0,945947	0,66151	0,522533	0,410795	0,557598
-2,56478	-0,69532185	-2,20114	0,450988	-1,43461	-0,68558266	-0,88924	0,035308	-0,520684	-0,08906	-0,783582974	-0,46234	-0,40317	-0,41475	0	0	0	-0,27097	1,14461	1,489629	1,048334	0,872615	0,615527	0,492767	0,389748	0,527462
-2,81911	-0,67308092	-2,39731	0,267556	-1,67505	-0,73597794	-1,05891	0,131579	-0,600006	-0,00567	-0,864993531	-0,45409	-0,46255	-0,45051	0	0	0	-0,31451	1,112393	1,048334	1,344183	0,96078	0,75897	0,556113	0,43903	0,616211
-2,45256	-0,56027825	-2,12229	0,209671	-1,47857	-0,56941932	-0,92218	0,22825	-0,533498	-0,06705	-0,887417855	-0,46301	-0,44277	-0,42732	0	0	0	-0,28156	0,945947	0,872615	0,96078	1,131931	0,635161	0,586606	0,441588	0,554695
-2,56837	-0,38373435	-2,31776	0,157296	-1,906	-0,41304722	-1,47538	0,148777	-0,964499	0,331099	-1,431379553	-0,2856	-0,83511	-0,61038	0	0	0	-0,5218	0,66151	0,615527	0,75897	0,635161	1,418519	0,951785	0,792582	1,046098
-2,23573	-0,24092177	-2,03523	0,19134	-1,72508	-0,22364654	-1,3267	0,10311	-0,794947	0,263575	-1,599144817	-0,40983	-0,68841	-0,5864	0	0	0	-0,38702	0,522533	0,492767	0,556113	0,586606	0,951785	1,761948	0,822387	0,861803
-1,91689	-0,21536946	-1,7591	0,126565	-1,52055	-0,20965402	-1,20023	0,063189	-0,832234	0,107021	-1,352020114	-0,23297	-0,81104	-0,5705	0	0	0	-0,32341	0,410795	0,389748	0,43903	0,441588	0,792582	0,822387	1,165308	0,850126
-2,52417	-0,3482442	-2,31588	0,119278	-1,97056	-0,36564248	-1,59855	0,066082	-1,181411	0,156656	-1,634129358	-0,34597	-1,11626	-0,70814	0	0	0	-0,85534	0,557598	0,527462	0,616211	0,554695	1,046098	0,861803	0,850126	1,694732

•Standardno odstupanje nepozatih parametara

$$m_{xpi} = \sigma_0 \cdot \sqrt{Q_{x_i x_i}} \qquad m_{ypi} = \sigma_0 \cdot \sqrt{Q_{y_i y_i}} \qquad m_{zi} = \sigma_0 \cdot \sqrt{Q_{z_i z_i}}$$

$m_{xp1} = 2.0576\ mm$	$m_{yp5} = 0.5150\ mm$	$m_{z1} = 0{,}8995$ "
$m_{yp1} = 0.7611\ mm$	$m_{xp6} = 1.1436\ mm$	$m_{z2} = 0.8630$ "
$m_{xp2} = 1.8205\ mm$	$m_{yp6} = 0.5967\ mm$	$m_{z3} = 0.8198$ "
$m_{yp2} = 0.6460\ mm$	$m_{xp7} = 0.7331\ mm$	$m_{z4} = 0.7523$ "
$m_{xp3} = 1.4129\ mm$	$m_{yp7} = 0.5753\ mm$	$m_{z5} = 0.8422$ "
$m_{yp3} = 0.7180\ mm$	$m_{xp8} = 0.0000\ mm$	$m_{z6} = 0.9386$ "
$m_{xp4} = 1.1089\ mm$	$m_{yp8} = 0.0000\ mm$	$m_{z7} = 0.7633$ "
$m_{yp4} = 0.4788\ mm$	$m_{xp9} = 0.0000\ mm$	$m_{z8} = 0.9205$ "
$m_{xp5} = 0.7811\ mm$	$m_{yp9} = 0.6071\ mm$	

•Standardno odstupanje položaja tačake

$$m_{Pi} = \sqrt{m_{xpi}^2 + m_{ypi}^2}$$

$$m_{P1} = 2.1938\ mm$$

$$m_{P2} = 1.9317\ mm$$

$$m_{P3} = 1.5849\ mm$$

$$m_{P4} = 1.2079\ mm$$

$$m_{P5} = 0.9356\ mm$$

$$m_{P6} = 1.2899\ mm$$

$$m_{P7} = 0.9319\ mm$$

$$m_{P8} = 0.0000\ mm$$

$$m_{P9} = 0.6071\ mm$$

•Elementi elipse grešaka

$$k = \sqrt{(Q_{xx} - Q_{yy})^2 + 4Q_{xy}^2} \qquad \lambda_1 = \frac{1}{2}(Q_{xx} + Q_{yy} + k) \qquad \lambda_2 = \frac{1}{2}(Q_{xx} + Q_{yy} - k)$$

$$c = \sigma_0\sqrt{\chi^2_{1-\alpha,2}} \qquad A = c\sqrt{\lambda_1} \qquad B = c\sqrt{\lambda_2} \qquad tg\,2\theta = \frac{2Q_{xy}}{Q_{xx} - Q_{yy}}$$

$$A - velika\ poluosa\ elipse, \qquad B - mala\ poluosa\ elipse,$$

$$\theta - ugao\ koji\ velika\ poluosa\ A\ zaklapa\ sa\ pravcem\ severa$$

$A_{P1} = 5.1427\ mm$	$B_{P1} = 1.5457\ mm$	$\theta_{P1} = 12° 14' 24''$	$\frac{A_{P1}}{B_{P1}} = 3.3271$
$A_{P2} = 4.4691\ mm$	$B_{P2} = 1.5442\ mm$	$\theta_{P2} = 355° 20' 26''$	$\frac{A_{P2}}{B_{P2}} = 2.8941$
$A_{P3} = 3.5819\ mm$	$B_{P3} = 1.4900\ mm$	$\theta_{P3} = 16° 37' 43''$	$\frac{A_{P3}}{B_{P3}} = 2.4039$
$A_{P4} = 2.7155\ mm$	$B_{P4} = 1.1692\ mm$	$\theta_{P4} = 358° 8' 17''$	$\frac{A_{P4}}{B_{P4}} = 2.3225$
$A_{P5} = 1.9185\ mm$	$B_{P5} = 1.2506\ mm$	$\theta_{P5} = 353° 43' 36''$	$\frac{A_{P5}}{B_{P5}} = 1.5341$
$A_{P6} = 2.8903\ mm$	$B_{P6} = 1.2710\ mm$	$\theta_{P6} = 16° 05' 27''$	$\frac{A_{P6}}{B_{P6}} = 2.2741$
$A_{P7} = 2.0851\ mm$	$B_{P7} = 0.9249\ mm$	$\theta_{P7} = 34° 37' 49''$	$\frac{A_{P7}}{B_{P7}} = 2.2544$
$A_{P9} = 1.4861\ mm$	$B_{P9} = 0.0000\ mm$	$\theta_{P9} = 00° 00' 00''$	

•Matrica kofaktora popravaka Q_V $\quad Q_V = P^{-1} - AQ_xA^T$

$$Q_{Vdiag} = [\ 0.5272\ \ 0.5735\ \ 0.4262\ \ 0.4298\ \ 0.5615\ \ 0.4812\ \ 0.2055\ \ 0.5226\ \ 0.5026\ \ 0.4720$$
$$0.4293\ \ 0.5140\ \ 0.6162\ \ 0.5125\ \ 0.3328\ \ 0.1960\ \ 0.2269\ \ 0.3813\ \ 0.3200\ \ 0.2473$$
$$0.2473\ \ 0.2603\ \ 0.1367\ \ 0.2419\ \ 0.3714\ \ 0.4219\ \ 0.2414\ \ 1.0356\ \ 1.1846\ \ 1.0151$$
$$1.0151\ \ 1.1400\ 1.1400\ 1.0356\ \ 0.1524\ \ 0.9750\ \ 0.9054\ \ 0.6250\ \ 1.0788\ \ 0.6664$$
$$0.9602\ \ 0.8229\ \ 1.0852\ \ 0.7917\ \ 1.0852\ 1.259]$$

• Koeficijenti unutrašnje pouzdanosti r_i

$$r_i = P_{ii}Q_{v_{ii}} \qquad r_i \geq 0.30 \Rightarrow Merenje\ je\ pouzdano$$

$r_1 = 0.5272$	$\boldsymbol{r_{24} = 0.2419}$
$r_2 = 0.5735$	$r_{25} = 0.3714$
$r_3 = 0.4262$	$r_{26} = 0.4219$
$r_4 = 0.4298$	$\boldsymbol{r_{27} = 0.2414}$
$r_5 = 0.5615$	$r_{28} = 0.7161$
$r_6 = 0.4812$	$r_{29} = 0.6451$
$\boldsymbol{r_7 = 0.2055}$	$r_{30} = 0.7022$
$r_8 = 0.5226$	$r_{31} = 0.7022$
$r_9 = 0.5026$	$r_{32} = 0.7441$
$r_{10} = 0.4720$	$r_{33} = 0.7441$
$r_{11} = 0.4293$	$r_{34} = 0.7161$
$r_{12} = 0.5140$	$\boldsymbol{r_{35} = 0.0947}$
$r_{13} = 0.6162$	$r_{36} = 0.6919$
$r_{14} = 0.5125$	$r_{37} = 0.6573$
$r_{15} = 0.3328$	$r_{38} = 0.5061$
$\boldsymbol{r_{16} = 0.1960}$	$r_{39} = 0.7574$
$\boldsymbol{r_{17} = 0.2269}$	$r_{40} = 0.4954$
$r_{18} = 0.3813$	$r_{41} = 0.7221$
$r_{19} = 0.3224$	$r_{42} = 0.6063$
$\boldsymbol{r_{20} = 0.2473}$	$r_{43} = 0.7748$
$\boldsymbol{r_{21} = 0.2473}$	$r_{44} = 0.5785$
$\boldsymbol{r_{22} = 0.2603}$	$r_{45} = 0.7748$
$\boldsymbol{r_{23} = 0.1367}$	$r_{46} = 0.9694$

•Marginalna gruba greška G_i koja se može otkriti *Data-snooping* testom

$$|G_i| = \frac{\sigma_0\sqrt{\lambda_0}}{P_i\sqrt{Q_{v_{ii}}}} \qquad |G_i| < 7\sigma_0 \qquad 7\sigma_0 = 4{,}9497$$

$$\lambda_0 = t_{1-\beta_0} + t_{1-\alpha/2} = 0{,}842 + 1{,}96 = 2{,}802$$

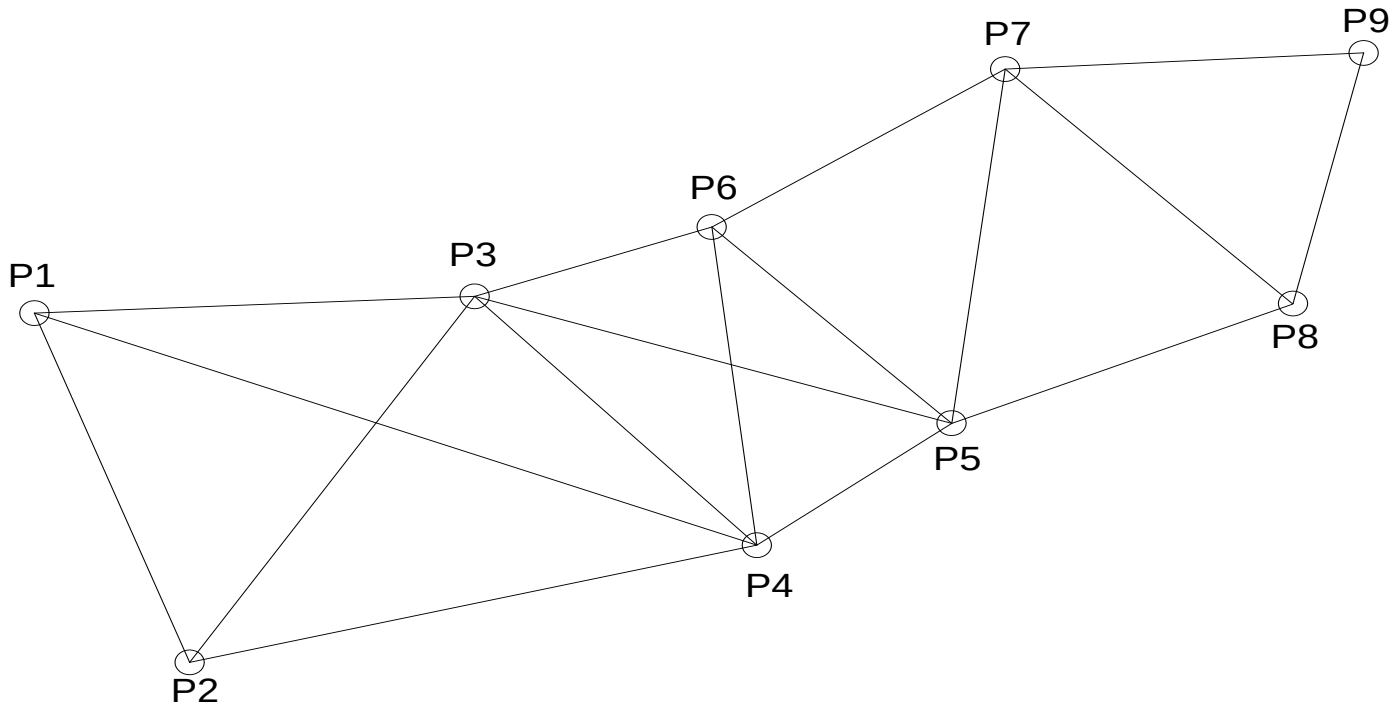
$G_1 = 1.4417$	$G_{17} = 0.9458$	$G_{32} = 3.2479$
$G_2 = 1.5037$	$G_{18} = 1.2261$	$G_{33} = 3.2479$
$G_3 = 1.2963$	$G_{19} = 1.1274$	$G_{34} = 2.9222$
$G_4 = 1.3017$	$G_{20} = 0.9874$	$G_{35} = 1.2471$
$G_5 = 1.4878$	$G_{21} = 0.9874$	$G_{36} = 2.7630$
$G_6 = 1.3774$	$G_{22} = 1.0130$	$G_{37} = 2.6026$
$G_7 = 0.9001$	$G_{23} = 0.7341$	$G_{38} = 1.9386$
$G_8 = 1.4354$	$G_{24} = 0.9766$	$G_{39} = 2.9375$
$G_9 = 1.4076$	$G_{25} = 1.2100$	$G_{40} = 2.1802$
$G_{10} = 1.3641$	$G_{26} = 1.2897$	$G_{41} = 2.5874$
$G_{11} = 1.3010$	$G_{27} = 0.9756$	$G_{42} = 2.4447$
$G_{12} = 1.4235$	$G_{28} = 2.9222$	$G_{43} = 2.8970$
$G_{13} = 1.5586$	$G_{29} = 3.9686$	$G_{44} = 2.4178$
$G_{14} = 1.4214$	$G_{30} = 2.8918$	$G_{45} = 2.8970$
$G_{15} = 1.1454$	$G_{31} = 2.8918$	$G_{46} = 2.8936$
$G_{16} = 0.8790$		

b)

•Plan opažanja

Plan opažanja			
Stanica	Vizura	Pravac	Dužina
P1	P3	X	X
	P4	X	X
	P2	X	X
P2	P1	X	X
	P3	X	X
	P4	X	/
P3	P6	X	/
	P5	X	/
	P4	X	/
	P2	X	X
	P1	X	X
P4	P2	X	X
	P1	X	/
	P3	X	X
	P6	X	X
	P5	X	X
P5	P3	X	/
	P7	X	X
	P8	X	/
P6	P7	X	X
	P5	X	X
P7	P6	X	/
	P9	X	X
	P8	X	X
P8	P5	X	X
	P7	X	X
	P9	X	X

•Skica mreže



• Jednačine popravaka za pravce

$$v_{\alpha_{p1-p3}} = a_{p1p3}\,\Delta\,x_{p1p3} + b_{p1p3}\,\Delta\,y_{p1p3} + c_{p1p3}\,\Delta\,z_1 + f_{\alpha_{p1-p3}}$$

$$v_{\alpha_{p1-p4}} = a_{p1p4}\,\Delta\,x_{p1p4} + b_{p1p4}\,\Delta\,y_{p1p4} + c_{p1p4}\,\Delta\,z_1 + f_{\alpha_{p1-p4}}$$

$$v_{\alpha_{p1-p2}} = a_{p1p2}\,\Delta\,x_{p1p2} + b_{p1p2}\,\Delta\,y_{p1p2} + c_{p1p2}\,\Delta\,z_1 + f_{\alpha_{p1-p2}}$$

$$v_{\alpha_{p2-p1}} = a_{p2p1}\,\Delta\,x_{p2p1} + b_{p2p1}\,\Delta\,y_{p2p1} + c_{p2p1}\,\Delta\,z_2 + f_{\alpha_{p2-p1}}$$

$$v_{\alpha_{p2-p3}} = a_{p2p3}\,\Delta\,x_{p2p3} + b_{p2p3}\,\Delta\,y_{p2p3} + c_{p2p3}\,\Delta\,z_2 + f_{\alpha_{p2-p3}}$$

$$v_{\alpha_{p2-p4}} = a_{p2p4}\,\Delta\,x_{p2p4} + b_{p2p4}\,\Delta\,y_{p2p4} + c_{p2p4}\,\Delta\,z_2 + f_{\alpha_{p2-p4}}$$

$$v_{\alpha_{p3-p6}} = a_{p3p6}\,\Delta\,x_{p3p6} + b_{p3p6}\,\Delta\,y_{p3p6} + c_{p3p6}\,\Delta\,z_3 + f_{\alpha_{p3-p6}}$$

$$v_{\alpha_{p3-p5}} = a_{p3p5}\,\Delta\,x_{p3p5} + b_{p3p5}\,\Delta\,y_{p3p5} + c_{p3p5}\,\Delta\,z_3 + f_{\alpha_{p3-p5}}$$

$$v_{\alpha_{p3-p4}} = a_{p3p4}\,\Delta\,x_{p3p4} + b_{p3p4}\,\Delta\,y_{p3p4} + c_{p3p4}\,\Delta\,z_3 + f_{\alpha_{p3-p4}}$$

$$v_{\alpha_{p3-p2}} = a_{p3p2}\,\Delta\,x_{p3p2} + b_{p3p2}\,\Delta\,y_{p3p2} + c_{p3p2}\,\Delta\,z_3 + f_{\alpha_{p3-p2}}$$

$$v_{\alpha_{p3-p1}} = a_{p3p1}\,\Delta\,x_{p3p1} + b_{p3p1}\,\Delta\,y_{p3p1} + c_{p3p1}\,\Delta\,z_3 + f_{\alpha_{p3-p1}}$$

$$v_{\alpha_{p4-p2}} = a_{p4p2}\,\Delta\,x_{p4p2} + b_{p4p2}\,\Delta\,y_{p4p2} + c_{p4p2}\,\Delta\,z_4 + f_{\alpha_{p4-p2}}$$

$$v_{\alpha_{p4-p1}} = a_{p4p1}\,\Delta\,x_{p4p1} + b_{p4p1}\,\Delta\,y_{p4p1} + c_{p4p1}\,\Delta\,z_4 + f_{\alpha_{p4-p1}}$$

$$v_{\alpha_{p4-p3}} = a_{p4p3}\,\Delta\,x_{p4p3} + b_{p4p3}\,\Delta\,y_{p4p3} + c_{p4p3}\,\Delta\,z_4 + f_{\alpha_{p4-p3}}$$

$$v_{\alpha_{p4-p6}} = a_{p4p6}\,\Delta\,x_{p4p6} + b_{p4p6}\,\Delta\,y_{p4p6} + c_{p4p6}\,\Delta\,z_4 + f_{\alpha_{p4-p6}}$$

$$v_{\alpha_{p4-p5}} = a_{p4p5}\,\Delta\,x_{p4p5} + b_{p4p5}\,\Delta\,y_{p4p5} + c_{p4p5}\,\Delta\,z_4 + f_{\alpha_{p4-p5}}$$

$$v_{\alpha_{p5-p3}} = a_{p5p3}\,\Delta\,x_{p5p3} + b_{p5p3}\,\Delta\,y_{p5p3} + c_{p5p3}\,\Delta\,z_5 + f_{\alpha_{p5-p3}}$$

$$v_{\alpha_{p5-p7}} = a_{p5p7}\,\Delta\,x_{p5p7} + b_{p5p7}\,\Delta\,y_{p5p7} + c_{p5p7}\,\Delta\,z_5 + f_{\alpha_{p5-p7}}$$

$$v_{\alpha_{p5-p8}} = a_{p5p8}\,\Delta\,x_{p5p8} + b_{p5p8}\,\Delta\,y_{p5p8} + c_{p5p8}\,\Delta\,z_5 + f_{\alpha_{p5-p8}}$$

$$v_{\alpha_{p6-p7}} = a_{p6p7}\,\Delta\,x_{p6p7} + b_{p6p7}\,\Delta\,y_{p6p7} + c_{p6p7}\,\Delta\,z_6 + f_{\alpha_{p6-p7}}$$

$$v_{\alpha_{p6-p5}} = a_{p6p5}\,\Delta\,x_{p6p5} + b_{p6p5}\,\Delta\,y_{p6p5} + c_{p6p5}\,\Delta\,z_6 + f_{\alpha_{p6-p5}}$$

$$v_{\alpha_{p7-p6}} = a_{p7p6}\,\Delta\,x_{p7p6} + b_{p7p6}\,\Delta\,y_{p7p6} + c_{p7p6}\,\Delta\,z_7 + f_{\alpha_{p7-p6}}$$

$$v_{\alpha_{p7-p9}} = a_{p7p9} \Delta x_{p7p9} + b_{p7p9} \Delta y_{p7p9} + c_{p7p9} \Delta z_7 + f_{\alpha_{p7-p9}}$$

$$v_{\alpha_{p7-p8}} = a_{p7p8} \Delta x_{p7p8} + b_{p7p8} \Delta y_{p7p8} + c_{p7p8} \Delta z_7 + f_{\alpha_{p7-p8}}$$

$$v_{\alpha_{p8-p5}} = a_{p8p5} \Delta x_{p8p5} + b_{p8p5} \Delta y_{p8p5} + c_{p8p5} \Delta z_8 + f_{\alpha_{p8-p5}}$$

$$v_{\alpha_{p8-p7}} = a_{p8p7} \Delta x_{p8p7} + b_{p8p7} \Delta y_{p8p7} + c_{p8p7} \Delta z_8 + f_{\alpha_{p8-p7}}$$

$$v_{\alpha_{p8-p9}} = a_{p8p9} \Delta x_{p8p9} + b_{p8p9} \Delta y_{p8p9} + c_{p8p9} \Delta z_8 + f_{\alpha_{p8-p9}}$$

$$a_{ij} = \frac{\rho'' \sin \nu_i^j}{D_{i-j}^0} \qquad b_{ij} = -\frac{\rho'' \cos \nu_i^j}{D_{i-j}^0} \qquad c_{ij} = 1$$

• Jednačine popravaka za dužine

$$v_{d_{p1-p3}} = A_{p1p3} \Delta x_{p1p3} + B_{p1p3} \Delta y_{p1p3} + f_{d_{p1-p3}}$$

$$v_{d_{p1-p4}} = A_{p1p4} \Delta x_{p1p4} + B_{p1p4} \Delta y_{p1p4} + f_{d_{p1-p4}}$$

$$v_{d_{p1-p2}} = A_{p1p2} \Delta x_{p1p2} + B_{p1p2} \Delta y_{p1p2} + f_{d_{p1-p2}}$$

$$v_{d_{p2-p1}} = A_{p2p1} \Delta x_{p2p1} + B_{p2p1} \Delta y_{p2p1} + f_{d_{p2-p1}}$$

$$v_{d_{p2-p3}} = A_{p2p3} \Delta x_{p2p3} + B_{p2p3} \Delta y_{p1p3} + f_{d_{p2-p3}}$$

$$v_{d_{p3-p2}} = A_{p3p2} \Delta x_{p3p2} + B_{p3p2} \Delta y_{p3p2} + f_{d_{p3-p2}}$$

$$v_{d_{p3-p1}} = A_{p3p1} \Delta x_{p3p1} + B_{p3p1} \Delta y_{p3p1} + f_{d_{p3-p1}}$$

$$v_{d_{p4-p2}} = A_{p4p2} \Delta x_{p4p2} + B_{p4p2} \Delta y_{p4p2} + f_{d_{p4-p2}}$$

$$v_{d_{p4-p3}} = A_{p4p3} \Delta x_{p4p3} + B_{p4p3} \Delta y_{p4p3} + f_{d_{p4-p3}}$$

$$v_{d_{p4-p6}} = A_{p4p6} \Delta x_{p4p6} + B_{p4p6} \Delta y_{p4p6} + f_{d_{p4-p6}}$$

$$v_{d_{p4-p5}} = A_{p4p5} \Delta x_{p4p5} + B_{p4p5} \Delta y_{p4p5} + f_{d_{p4-p5}}$$

$$v_{d_{p5-p7}} = A_{p5p7} \Delta x_{p5p7} + B_{p5p7} \Delta y_{p5p7} + f_{d_{p5-p7}}$$

$$v_{d_{p6-p7}} = A_{p6p7} \Delta x_{p6p7} + B_{p6p7} \Delta y_{p6p7} + f_{d_{p6-p7}}$$

$$v_{d_{p6-p5}} = A_{p6p5} \Delta x_{p6p5} + B_{p6p5} \Delta y_{p6p5} + f_{d_{p6-p5}}$$

$$v_{d_{p7-p9}} = A_{p7p9} \Delta x_{p7p9} + B_{p7p9} \Delta y_{p7p9} + f_{d_{p7-p9}}$$

$$v_{d_{p7-p8}} = A_{p7p8} \Delta x_{p7p8} + B_{p7p8} \Delta y_{p7p8} + f_{d_{p7-p8}}$$

$$v_{d_{p8-p5}} = A_{p8p5} \Delta x_{p8p5} + B_{p8p5} \Delta y_{p8p5} + f_{d_{p8-p5}}$$

$$v_{d_{p8-p7}} = A_{p8p7} \Delta x_{p8p7} + B_{p8p7} \Delta y_{p8p7} + f_{d_{p8-p7}}$$

$$v_{d_{p8-p9}} = A_{p8p9} \Delta x_{p8p9} + B_{p8p9} \Delta y_{p8p9} + f_{d_{p8-p9}}$$

$$A_{ij} = -\sin \nu_i^j \qquad B_{ij} = -\cos \nu_i^j$$

•Homogenizacija težina

Standarno odstupanje pravca je $\sigma_{\alpha_{i-j}} = 1"$.

Pravci su mereni u dva girusa.Dužine su merene u dva ponavljanja.

$$\sigma_{\alpha_i} = \frac{\sigma_{\alpha_{i-j}}}{\sqrt{2}} = \frac{1}{\sqrt{2}} = 0.7071"$$

$P_{\alpha_{i-j}} = \frac{\sigma_0^2}{\sigma_{\alpha_{i-j}}^2} = \frac{c}{\sigma_{\alpha_i - j}^2}$, $\sigma_0^2 = 0.7071^2 = 0.5$ $P_{d_{i-j}} = \frac{\sigma_0^2}{\sigma_{d_{i-j}}^2} = \frac{c}{\sigma_{d_{i-j}}^2}$, $\sigma_{d_{i-j}} = \frac{1mm+1ppm}{\sqrt{2}}$

$P_{\alpha_{i-j}} = 1$

$\sigma_{d_{p1-p3}} = 0.8504\ mm$ $\sigma_{d_{p5-p7}} = 0.8439\ mm$

$\sigma_{d_{p1-p4}} = 0.9582\ mm$ $\sigma_{d_{p6-p7}} = 0.8201\ mm$

$\sigma_{d_{p1-p2}} = 0.8502\ mm$ $\sigma_{d_{p6-p5}} = 0.8154\ mm$

$\sigma_{d_{p2-p1}} = 0.8502\ mm$ $\sigma_{d_{p7-p9}} = 0.8238\ mm$

$\sigma_{d_{p2-p3}} = 0.8752\ mm$ $\sigma_{d_{p7-p8}} = 0.8368\ mm$

$\sigma_{d_{p3-p2}} = 0.8752\ mm$ $\sigma_{d_{p8-p5}} = 0.8272\ mm$

$\sigma_{d_{p3-p1}} = 0.8504\ mm$ $\sigma_{d_{p8-p7}} = 0.8368\ mm$

$\sigma_{d_{p4-p2}} = 0.8969\ mm$ $\sigma_{d_{p8-p9}} = 0.8059\ mm$

$\sigma_{d_{p4-p3}} = 0.8394\ mm$ $\sigma_{d_{p4-p5}} = 0.7858\ mm$

$\sigma_{d_{p4-p6}} = 0.8299\ mm$

•Matrica dizajna A

$A =$

X1	Y1	X2	Y2	X3	Y3	X4	Y4	X5	Y5	X6	Y6	X7	Y7	X8	Y8	X9	Y9	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8
1,017111	-0,04561188	0	0	-1,01711	0,045611884	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0,543159	0,205687647	0	0	0	0	-0,54316	-0,20569	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0,359612	0,954046814	-0,35961	-0,95405	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0,359612	0,954046814	-0,35961	-0,95405	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0,478158	-0,72392	-0,47816	0,723916463	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0,746669	-0,18192	0	0	-0,74667	0,181917	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	1,691358	-0,58358988	0	0	0	0	-1,691358379	0,58359	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0,856612	0,268485924	0	0	-0,856612	-0,26849	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0,76424	0,794354102	-0,76424	-0,79435	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0,478158	-0,72392	-0,47816	0,723916463	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
1,017111	-0,04561188	0	0	-1,01711	0,045611884	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0,746669	-0,18192	0	0	-0,74667	0,181917	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0,543159	0,205687647	0	0	0	0	-0,54316	-0,20569	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0,76424	0,794354102	-0,76424	-0,79435	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	-0,14191	-1,17901	0	0	0,141912895	1,179011	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	1,49072	-1,1012	-1,49072	1,101196	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0,856612	0,268485924	0	0	-0,856612	-0,26849	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0,135826	-1,05743	0	0	-0,13583	1,057427	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	1,122508	-0,46358	0	0	0	0	-1,12251	0,463576	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	1,090197883	-0,69145	-1,0902	0,691454	0	0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	-0,969356	-0,93461	0,969355544	0,934607	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	1,090197883	-0,69145	-1,0902	0,691454	0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	1,248107	-0,06631	0	0	-1,24811	-1,24811	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0,810971	0,778711	-0,81097	-0,77871	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	1,122508	-0,46358	0	0	0	0	-1,12251	0,463576	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0,810971	0,778711	-0,81097	-0,77871	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,343381	-1,43655	-0,34338	1,436552	0	0	0	0	0	0	0	1
-0,0448	-0,998996	0	0	0,0448	0,998995997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0,354145	-0,93519038	0	0	0	0	-0,35415	0,93519	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0,935733	-0,35270904	-0,93573	0,352709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0,935733	-0,35270904	-0,93573	0,352709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	-0,83441	-0,55114	0,834412	0,551141606	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	-0,83441	-0,55114	0,834412	0,551141606	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0,0448	-0,998996	0	0	0,0448	0,998995997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	-0,23671	0,746669	0	0	0,236714	0,971579	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0,720634	-0,69331535	-0,72063	0,693315	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-0,99283	0,119503	0	0	0,992833785	-0,1195	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	-0,59417	-0,80434	0,594167	0,804341	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	-0,991851	-0,1274	0	0	0,991851	0,127402	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	-0,535602013	-0,84447	0,535602	0,844471	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	-0,694086	0,719892	0,694086157	-0,71989	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-0,05306	-0,99859	0	0	0,053057	0,721308	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0,692615	-0,72131	-0,69261	0,721308	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	-0,381712	-0,92428	0	0	0	0	0,381712	0,924281	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0,692615	-0,72131	-0,69261	0,721308	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0,9726	-0,23248	0,972601	0,232482	0	0	0	0	0	0	0	0

•Matrica težina P

$$P_{diag} = [\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1$$

$$0.691\ \ 0.545\ \ 0.692\ \ \ 0.692\ \ \ 0.653\ \ 0.653\ \ 0.691\ \ 0.622\ \ 0.710\ \ 0.726$$

$$0.810\ \ 0.702\ \ 0.743\ \ 0.752\ \ 0.737\ \ 0.714\ \ 0.731\ \ 0.714\ \ 0.770\ ]$$

•Matrica koeficijenata normalnih jednačina N $N = A^T PA$

$N =$

4,200231	0,241738832	-1,47009	-0,22954	-2,0718	0,030893178	-0,65834	-0,04309	0	0	0	0	0	0	0	0	0	0	1,919882	0,359612	1,017111	0,543159	0	0	0	0
0,241739	3,937688153	-0,22954	-1,99253	0,030893	-1,38429504	-0,04309	-0,56086	0	0	0	0	0	0	0	0	0	0	1,114123	0,954047	-0,04561	0,205688	0	0	0	0
-1,47009	-0,22953895	3,986136	-0,24392	-1,36619	0,091936571	-1,14986	0,128711	0	0	0	0	0	0	0	0	0	0	-0,35961	0,865214	0,478158	0,746669	0	0	0	0
-0,22954	-1,99253149	-0,24392	3,849908	0,091937	-1,44465437	0,381524	0,384729	0	0	0	0	0	0	0	0	0	0	-0,95405	-1,85988	-0,72392	-0,18192	0	0	0	0
-2,0718	0,030893178	-1,36619	0,091937	9,302883	0,209710641	-1,53663	-0,85962	-1,467567	-0,45998	-2,860693165	0,98706	0	0	0	0	0	0	-1,01711	-0,47816	1,816942	0,76424	0,856612	0	0	0
0,030893	-1,38429504	0,091937	-1,44465	0,209711	4,916783963	-0,85962	-1,60309	-0,459976	-0,14417	0,98705963	-0,34058	0	0	0	0	0	0	0,045612	0,723916	1,248778	0,794354	0,268486	0	0	0
-0,65834	-0,04309306	-1,14986	0,381524	-1,53663	-0,85962375	6,588628	-0,3994	-2,50811	1,254591	-0,735695106	-0,08119	0	0	0	0	0	0	-0,54316	-0,74667	-0,76424	-0,70526	0	0	0	0
-0,04309	-0,56086163	0,128711	0,384729	-0,85962	-1,60308803	-0,3994	5,953815	1,254591	-1,7365	-0,081188294	-1,40043	0	0	0	0	0	0	-0,20569	0,181917	-0,79435	-3,09833	0	0	0	0
0	0	0	0	-1,46757	-0,45997627	-2,50811	1,254591	8,613226	-1,10223	-1,301918625	-0,53023	-0,70911	0,05491	-2,62652	0,782934	0	0	0	0	-0,85661	-1,49072	0,401722	-0,96936	0	1,122508
0	0	0	0	-0,45998	-0,14416938	1,254591	-1,7365	-1,10223	5,327467	-0,530229349	-1,2632	0,05491	-1,12955	0,782934	-1,05405	0	0	0	0	-0,26849	1,101196	-1,78949	-0,93461	0	-0,46358
0	0	0	0	-2,86069	0,98705963	-0,7357	-0,08119	-1,301919	-0,53023	7,488643813	-1,54702	-2,59034	1,171378	0	0	0	0	0	0	-1,69136	0,141913	0	2,059553	1,090198	0
0	0	0	0	0,98706	-0,34057715	-0,08119	-1,40043	-0,530229	-1,2632	-1,547020483	4,490605	1,171378	-1,4864	0	0	0	0	0	0	0,58359	1,179011	0	0,243154	-0,69145	0
0	0	0	0	0	0	0	0	-0,709113	0,05491	-2,590336917	1,171378	6,859668	-0,7204	-2,00037	-0,54962	-1,55985	-1,58597	0	0	0	0	-0,13583	-1,0902	0,96888	0,810971
0	0	0	0	0	0	0	0	0,05491	-1,12955	1,171378495	-1,4864	-0,7204	5,310765	-0,54962	-1,95574	0,043732	-0,44791	0	0	0	0	1,057427	0,691454	1,40385	0,778711
0	0	0	0	0	0	0	0	-2,626518	0,782934	0	0	-2,00037	-0,54962	5,473127	-0,55251	-0,84624	0,319192	0	0	0	0	-1,12251	0	-0,81097	-1,5901
0	0	0	0	0	0	0	0	0,782934	-1,05405	0	0	-0,54962	-1,95574	-0,55251	5,115085	0,319192	-2,10529	0	0	0	0	0,463576	0	-0,77871	-1,75169
0	0	0	0	0	0	0	0	0	0	0	0	-1,55985	0,043732	-0,84624	0,319192	2,406084	1,266776	0	0	0	0	0	0	-1,24811	-0,34338
0	0	0	0	0	0	0	0	0	0	0	0	-1,58597	-0,44791	0,319192	-2,10529	1,266776	4,046392	0	0	0	0	0	0	-1,24811	1,436552
1,919882	1,114122578	-0,35961	-0,95405	-1,01711	0,045611884	-0,54316	-0,20569	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
0,359612	0,954046814	0,865214	-1,85988	-0,47816	0,723916463	-0,74667	0,181917	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
1,017111	-0,04561188	0,478158	-0,72392	1,816942	1,248778494	-0,76424	-0,79435	-0,856612	-0,26849	-1,691358379	0,58359	0	0	0	0	0	0	0	0	5	0	0	0	0	0
0,543159	0,205687647	0,746669	-0,18192	0,76424	0,794354102	-0,70526	-3,09833	-1,49072	1,101196	0,141912895	1,179011	0	0	0	0	0	0	0	0	0	5	0	0	0	0
0	0	0	0	0,856612	0,268485924	0	0	0,401722	-1,78949	0	0	-0,13583	1,057427	-1,12251	0,463576	0	0	0	0	0	0	3	0	0	0
0	0	0	0	0	0	0	0	-0,969356	-0,93461	2,059553427	0,243154	-1,0902	0,691454	0	0	0	0	0	0	0	0	0	2	0	0
0	0	0	0	0	0	0	0	0	0	1,090197883	-0,69145	0,96888	1,40385	-0,81097	-0,77871	-1,24811	-1,24811	0	0	0	0	0	0	3	0
0	0	0	0	0	0	0	0	1,122508	-0,46358	0	0	0,810971	0,778711	-1,5901	-1,75169	-0,34338	1,436552	0	0	0	0	0	0	0	3

•Matrica datumskih uslova B

Datum je definisan minimalnim tragom na sve tacke.

$B^T =$

X1	Y1	X2	Y2	X3	Y3	X4	Y4	X5	Y5	X6	Y6	X7	Y7	X8	Y8	X9	Y9	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8
0,333333	0	0,333333333	0	0,33333333	0	0,333333	0	0,33333333	0	0,333333333	0	0,333333	0	0,333333	0	0,333333	0	0	0	0	0	0	0	0	0
0	0,333333333	0	0,3333333	0	0,333333	0	0,333333	0	0,333333	0	0,33333333	0	0,333333	0	0,333333	0	0,333333	0	0	0	0	0	0	0	0
-0,49281	0,006712014	-0,386429227	-0,2755275	-0,1910678	0,020244	0,002358	-0,1808	0,13582364	-0,08221	-0,028588967	0,07630577	0,172574	0,203892	0,36987	0,014444	0,418275	0,216947	0	0	0	0	0	0	0	0

•Matrica koeficijenata normalnih jednačina N proširena matricom datumskih uslova B $\quad N = N + BB^T \quad \begin{bmatrix} N & B \\ B^T & 0 \end{bmatrix}$

$$\begin{bmatrix} N & B \\ B^T & 0 \end{bmatrix} =$$

4,200231	0,241738832	-1,470088177	-0,2295389	-2,0718044	0,030893	-0,65834	-0,04309	0	0	0	0	0	0	0	0	0	0	1,919882	0,359612	1,017111	0,543159	0	0	0	0	0,333333	0	-0,49281
0,2417388	3,937688153	-0,229538947	-1,9925315	0,03089318	-1,3843	-0,04309	-0,56086	0	0	0	0	0	0	0	0	0	0	1,114123	0,954047	-0,04561	0,205688	0	0	0	0	0	0,333333	0,006712
-1,470088	-0,229538947	3,986135523	-0,2439213	-1,3661907	0,091937	-1,14986	0,128711	0	0	0	0	0	0	0	0	0	0	-0,35961	0,865214	0,478158	0,746669	0	0	0	0	0,333333	0	-0,38643
-0,229539	-1,992531487	-0,243921336	3,8499075	0,09193657	-1,44465	0,381524	0,384729	0	0	0	0	0	0	0	0	0	0	-0,95405	-1,85988	-0,72392	-0,18192	0	0	0	0	0	0,333333	-0,27553
-2,071804	0,030893178	-1,366190681	0,0919366	9,30288275	0,209711	-1,53663	-0,85962	-1,4675666	-0,45998	-2,860693165	0,98705963	0	0	0	0	0	0	-1,01711	-0,47816	1,816942	0,76424	0,856612	0	0	0	0,333333	0	-0,19107
0,0308932	-1,384295038	0,091936571	-1,4446544	0,20971064	4,916784	-0,85962	-1,60309	-0,4599763	-0,14417	0,98705963	-0,34057715	0	0	0	0	0	0	0,045612	0,723916	1,248778	0,794354	0,268486	0	0	0	0	0,333333	0,020244
-0,658338	-0,043093063	-1,149856665	0,3815237	-1,5366279	-0,85962	6,588628	-0,3994	-2,5081096	1,254591	-0,735695106	-0,08118829	0	0	0	0	0	0	-0,54316	-0,74667	-0,76424	-0,70526	0	0	0	0	0,333333	0	0,002358
-0,043093	-0,560861627	0,12871063	0,3847294	-0,8596237	-1,60309	-0,3994	5,953815	1,25459101	-1,7365	-0,081188294	-1,40043453	0	0	0	0	0	0	-0,20569	0,181917	-0,79435	-3,09833	0	0	0	0	0	0,333333	-0,1808
0	0	0	0	-1,4675666	-0,45998	-2,50811	1,254591	8,61322576	-1,10223	-1,301918625	-0,53022935	-0,70911	0,05491	-2,62652	0,782934	0	0	0	0	-0,85661	-1,49072	0,401722	-0,96936	0	1,122508	0,333333	0	0,135824
0	0	0	0	-0,4599763	-0,14417	1,254591	-1,7365	-1,1022297	5,327467	-0,530229349	-1,26319796	0,05491	-1,12955	0,782934	-1,05405	0	0	0	0	-0,26849	1,101196	-1,78949	-0,93461	0	-0,46358	0	0,333333	-0,08221
0	0	0	0	-2,8606932	0,98706	-0,7357	-0,08119	-1,3019186	-0,53023	7,488643813	-1,54702048	-2,59034	1,171378	0	0	0	0	0	0	-1,69136	0,141913	0	2,059553	1,090198	0	0,333333	0	-0,02859
0	0	0	0	0,98705963	-0,34058	-0,08119	-1,40043	-0,5302293	-1,2632	-1,547020483	4,49060492	1,171378	-1,4864	0	0	0	0	0	0	0,58359	1,179011	0	0,243154	-0,69145	0	0	0,333333	0,076306
0	0	0	0	0	0	0	0	-0,7091134	0,05491	-2,590336917	1,17137849	6,859668	-0,7204	-2,00037	-0,54962	-1,55985	-1,58597	0	0	0	0	-0,13583	-1,0902	0,96888	0,810971	0,333333	0	0,172574
0	0	0	0	0	0	0	0	0,05491029	-1,12955	1,171378495	-1,48639529	-0,7204	5,310765	-0,54962	-1,95574	0,043732	-0,44791	0	0	0	0	1,057427	0,691454	1,40385	0,778711	0	0,333333	0,203892
0	0	0	0	0	0	0	0	-2,6265175	0,782934	0	0	-2,00037	-0,54962	5,473127	-0,55251	-0,84624	0,319192	0	0	0	0	-1,12251	0	-0,81097	-1,5901	0,333333	0	0,36987
0	0	0	0	0	0	0	0	0,78293405	-1,05405	0	0	-0,54962	-1,95574	-0,55251	5,115085	0,319192	-2,10529	0	0	0	0	0,463576	0	-0,77871	-1,75169	0	0,333333	0,014444
0	0	0	0	0	0	0	0	0	0	0	0	-1,55985	0,043732	-0,84624	0,319192	2,406084	1,266776	0	0	0	0	0	0	-1,24811	-0,34338	0,333333	0	0,418275
0	0	0	0	0	0	0	0	0	0	0	0	-1,58597	-0,44791	0,319192	-2,10529	1,266776	4,046392	0	0	0	0	0	0	-1,24811	1,436552	0	0,333333	0,216947
1,9198815	1,114122578	-0,359612108	-0,9540468	-1,0171108	0,045612	-0,54316	-0,20569	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
0,3596121	0,954046814	0,865214295	-1,8598801	-0,4781578	0,723916	-0,74667	0,181917	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
1,0171108	-0,045611884	0,478157808	-0,7239165	1,8169417	1,248778	-0,76424	-0,79435	-0,8566115	-0,26849	-1,691358379	0,58358988	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
0,5431586	0,205687647	0,746668595	-0,1819169	0,76424043	0,794354	-0,70526	-3,09833	-1,4907197	1,101196	0,141912895	1,17901127	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
0	0	0	0	0,85661153	0,268486	0	0	0,40172228	-1,78949	0	0	-0,13583	1,057427	-1,12251	0,463576	0	0	0	0	0	0	3	0	0	0	0	0	0
0	0	0	0	0	0	0	0	-0,9693555	-0,93461	2,059553427	0,24315371	-1,0902	0,691454	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1,090197883	-0,69145359	0,96888	1,40385	-0,81097	-0,77871	-1,24811	-1,24811	0	0	0	0	0	0	3	0	0	0	0
0	0	0	0	0	0	0	0	1,12250826	-0,46358	0	0	0,810971	0,778711	-1,5901	-1,75169	-0,34338	1,436552	0	0	0	0	0	0	0	3	0	0	0
0,3333333	0	0,333333333	0	0,33333333	0	0,333333	0	0,33333333	0	0,333333333	0	0,333333	0	0,333333	0	0,333333	0	0	0	0	0	0	0	0	0	0	0	0
0	0,333333333	0	0,3333333	0	0,333333	0	0,333333	0	0,333333	0	0,33333333	0	0,333333	0	0,333333	0	0,333333	0	0	0	0	0	0	0	0	0	0	0
-0,492815	0,006712014	-0,386429227	-0,2755275	-0,1910678	0,020244	0,002358	-0,1808	0,13582364	-0,08221	-0,028588967	0,07630577	0,172574	0,203892	0,36987	0,014444	0,418275	0,216947	0	0	0	0	0	0	0	0	0	0	0

•Matrica kofaktora nepoznatih parametara $N^+ = Q_x \quad N^+ = (N + BB^T)^{-1} - BB^T \quad \begin{bmatrix} N^+ & B^+ \\ B^{T+} & 0^+ \end{bmatrix}$

$$N^+ =$$

0,3599054	0,028010872	0,050851243	-0,2583791	-0,069473	0,041984	-0,18067	-0,09814	-0,1400899	0,072625	-0,235797539	0,04906259	-0,06331	0,015937	0,085384	0,139806	0,193205	0,009095	-0,38043	-0,28712	-0,24927	-0,20223	0,08002	0,162872	0,253521	0,221265
0,0280109	0,46910986	0,006923987	0,1797823	-0,0901758	0,209773	-0,05962	-0,00854	-0,0411698	-0,06962	-0,181755132	-0,10567533	-0,0721	-0,22713	0,10687	-0,15967	0,303009	-0,28803	-0,17928	-0,12239	-0,06608	-0,01694	0,112414	0,186753	0,164939	0,219115
0,0508512	0,006923987	0,21818413	-0,1401113	-0,0438972	0,021258	-0,08785	-0,07295	-0,084068	0,027998	-0,141794817	0,02690591	-0,04261	0,020908	0,037427	0,084436	0,093765	0,024633	-0,08963	-0,18765	-0,12981	-0,1313	0,030247	0,084626	0,143001	0,109951
-0,258379	0,179782343	-0,140111288	0,6835404	-0,0340297	0,103106	0,102591	0,010851	0,0960378	-0,15577	0,030901602	-0,17036683	0,0179	-0,19995	0,052443	-0,23456	0,132647	-0,21663	0,305381	0,432547	0,209011	0,178715	0,021872	0,041534	-0,04436	-0,00319
-0,069473	-0,09017579	-0,043897161	-0,0340297	0,13041391	-0,06597	0,043452	-0,00805	0,03047711	-0,03211	0,100379779	0,00270015	0,027957	0,088847	-0,07206	0,020739	-0,14725	0,118056	0,114398	0,076577	0,024166	0,020932	-0,11479	-0,11941	-0,1127	-0,14646
0,0419844	0,209772605	0,021257839	0,103106	-0,0659709	0,358687	-0,03538	0,016281	-0,0369395	-0,04577	-0,21115495	-0,06579874	-0,08387	-0,19231	0,094771	-0,12881	0,275309	-0,25517	-0,10255	-0,12081	-0,1347	-0,03384	0,083733	0,206917	0,179209	0,20806
-0,180673	-0,059617525	-0,087852618	0,1025908	0,04345186	-0,03538	0,266776	0,052717	0,11632487	-0,11944	0,142872975	-0,03376297	0,033895	0,056593	-0,10514	-0,07074	-0,22966	0,107045	0,227043	0,208221	0,167449	0,173101	-0,14288	-0,14355	-0,19493	-0,26041
-0,098141	-0,008535662	-0,072950522	0,0108508	-0,0080546	0,016281	0,052717	0,290389	0,03375956	0,024479	0,040600954	0,00035298	-0,01547	-0,08794	0,014346	-0,10839	0,053194	-0,13748	0,087159	0,032545	0,102278	0,211764	0,063337	0,00792	-0,02785	0,034398
-0,14009	-0,041169757	-0,084067978	0,0960378	0,03047711	-0,03694	0,116325	0,03376	0,21038969	-0,03989	0,113035684	-0,0313164	0,046542	0,029136	-0,0688	-0,09163	-0,22381	0,08201	0,159676	0,154347	0,147155	0,147186	-0,07711	-0,01397	-0,17834	-0,25989
0,0726248	-0,069620982	0,027997531	-0,1557668	-0,0321102	-0,04577	-0,11944	0,024479	-0,0398891	0,35078	-0,07167677	0,07634141	-0,04454	-0,06562	0,072259	0,034972	0,134772	-0,14979	-0,09694	-0,11649	-0,05306	-0,10949	0,270592	0,207528	0,111096	0,244077
-0,235798	-0,181755132	-0,141794817	0,0309016	0,10037978	-0,21115	0,142873	0,040601	0,11303568	-0,07168	0,503766817	0,06411846	0,1161	0,17456	-0,18941	-0,04705	-0,40915	0,201457	0,277125	0,246168	0,287334	0,138976	-0,18753	-0,50234	-0,43729	-0,40123
0,0490626	-0,105675327	0,026905913	-0,1703668	0,00270015	-0,0658	-0,03376	0,000353	-0,0313164	0,076341	0,064118462	0,30791043	-0,07713	0,042894	-0,01412	-0,00943	0,013545	-0,07623	-0,04728	-0,07777	-0,04335	-0,10628	0,03241	-0,13984	0,020162	0,058289
-0,063312	-0,072095701	-0,042614909	0,0178997	0,02795686	-0,08387	0,033895	-0,01547	0,04654247	-0,04454	0,11609999	-0,07712887	0,214218	0,085651	-0,09805	-0,00012	-0,23474	0,189678	0,083706	0,087974	0,086258	0,059682	-0,09043	-0,02128	-0,21451	-0,27417
0,0159366	-0,22713211	0,020907628	-0,1999528	0,08884673	-0,19231	0,056593	-0,08794	0,02913601	-0,06562	0,174559925	0,04289376	0,085651	0,407965	-0,14489	0,088971	-0,32674	0,233126	0,050333	0,020312	0,029669	-0,02425	-0,25909	-0,29587	-0,32714	-0,32397
0,085384	0,106870364	0,03742745	0,0524432	-0,0720625	0,094771	-0,10514	0,014346	-0,0688038	0,072259	-0,189411034	-0,01412401	-0,09805	-0,14489	0,251734	0,026305	0,158917	-0,20798	-0,11709	-0,08389	-0,09399	-0,05506	0,201168	0,193834	0,21951	0,367592
0,1398062	-0,159667777	0,084435752	-0,2345643	0,02073869	-0,12881	-0,07074	-0,10839	-0,0916283	0,034972	-0,047051231	-0,00943082	-0,00012	0,088971	0,026305	0,367222	-0,06174	0,149695	-0,1059	-0,1124	-0,10397	-0,12107	-0,03953	-0,0093	0,112354	0,166242
0,1932047	0,303008683	0,09376466	0,132647	-0,1472469	0,275309	-0,22966	0,053194	-0,2238081	0,134772	-0,409151855	0,01354512	-0,23474	-0,32674	0,158917	-0,06174	0,798714	-0,52399	-0,27479	-0,21462	-0,2393	-0,15128	0,301309	0,359201	0,521742	0,643352
0,0090951	-0,288032951	0,02463316	-0,2166289	0,11805554	-0,25517	0,107045	-0,13748	0,08200972	-0,14979	0,20145714	-0,07622687	0,189678	0,233126	-0,20798	0,149695	-0,52399	0,740514	0,089068	0,064472	0,060202	0,021397	-0,28574	-0,20564	-0,18841	-0,60302
-0,380433	-0,179279023	-0,089631473	0,3053806	0,11439795	-0,10255	0,227043	0,087159	0,15967573	-0,09694	0,277124536	-0,04727994	0,083706	0,050333	-0,11709	-0,1059	-0,27479	0,089068	0,817174	0,411992	0,282542	0,230277	-0,14409	-0,21931	-0,2986	-0,30842
-0,287121	-0,122393598	-0,18765443	0,4325469	0,07657661	-0,12081	0,208221	0,032545	0,15434674	-0,11649	0,246167806	-0,07777188	0,087974	0,020312	-0,08389	-0,1124	-0,21462	0,064472	0,411992	0,820165	0,289742	0,220038	-0,11841	-0,18274	-0,25962	-0,27034
-0,249268	-0,066083024	-0,129812438	0,2090109	0,02416602	-0,1347	0,167449	0,102278	0,1471548	-0,05306	0,287333943	-0,04335098	0,086258	0,029669	-0,09399	-0,10397	-0,2393	0,060202	0,282542	0,289742	0,484101	0,219116	-0,07185	-0,20733	-0,28305	-0,26102
-0,202233	-0,01693987	-0,131303782	0,1787154	0,0209317	-0,03384	0,173101	0,211764	0,14718576	-0,10949	0,138975642	-0,10627781	0,059682	-0,02425	-0,05506	-0,12107	-0,15128	0,021397	0,230277	0,220038	0,219116	0,495705	-0,07861	-0,0691	-0,18327	-0,20927
0,0800199	0,112413889	0,030247456	0,0218724	-0,1147874	0,083733	-0,14288	0,063337	-0,0771107	0,270592	-0,187528904	0,03241006	-0,09043	-0,25909	0,201168	-0,03953	0,301309	-0,28574	-0,14409	-0,11841	-0,07185	-0,07861	0,698955	0,318525	0,276659	0,417222
0,1628721	0,186753037	0,084625664	0,0415341	-0,1194081	0,206917	-0,14355	0,00792	-0,0139661	0,207528	-0,502335653	-0,13983861	-0,02128	-0,29587	0,193834	-0,0093	0,359201	-0,20564	-0,21931	-0,18274	-0,20733	-0,0691	0,318525	1,215198	0,409513	0,356742
0,2535214	0,164938658	0,143000984	-0,0443583	-0,1127021	0,179209	-0,19493	-0,02785	-0,1783371	0,111096	-0,437294956	0,02016153	-0,21451	-0,32714	0,21951	0,112354	0,521742	-0,18841	-0,2986	-0,25962	-0,28305	-0,18327	0,276659	0,409513	0,946436	0,55869
0,2212654	0,219114905	0,10995097	-0,0031899	-0,146456	0,20806	-0,26041	0,034398	-0,2598868	0,244077	-0,401232095	0,058289	-0,27417	-0,32397	0,367592	0,166242	0,643352	-0,60302	-0,30842	-0,27034	-0,26102	-0,20927	0,417222	0,356742	0,55869	1,280799

•Standardno odstupanje nepozatih parametara

$$m_{xpi} = \sigma_0 \cdot \sqrt{Q_{x_i x_i}} \qquad m_{ypi} = \sigma_0 \cdot \sqrt{Q_{y_i y_i}} \qquad m_{zi} = \sigma_0 \cdot \sqrt{Q_{z_i z_i}}$$

$m_{xp1} = 0.4242\ mm$ $m_{yp5} = 0.4188\ mm$ $m_{z1} = 0{,}6392$ "

$m_{yp1} = 0.4843\ mm$ $m_{xp6} = 0.5019\ mm$ $m_{z2} = 0.6404$ "

$m_{xp2} = 0.3303\ mm$ $m_{yp6} = 0.3924 mm$ $m_{z3} = 0.4920$ "

$m_{yp2} = 0.5846\ mm$ $m_{xp7} = 0.3273\ mm$ $m_{z4} = 0.4978$ "

$m_{xp3} = 0.2554\ mm$ $m_{yp7} = 0.4516\ mm$ $m_{z5} = 0.5912$ "

$m_{yp3} = 0.4235\ mm$ $m_{xp8} = 0.3548\ mm$ $m_{z6} = 0.7795$ "

$m_{xp4} = 0.3652\ mm$ $m_{yp8} = 0.4285\ mm$ $m_{z7} = 0.6879$ "

$m_{yp4} = 0.3810\ mm$ $m_{xp9} = 0.6319\ mm$ $m_{z8} = 0.8002$ "

$m_{xp5} = 0.3243\ mm$ $m_{yp9} = 0.6085\ mm$

•Standardno odstupanje položaja tačake

$$m_{Pi} = \sqrt{m_{xpi}^2 + m_{ypi}^2}$$

$m_{P1} = 0.6438\ mm$

$m_{P2} = 0.6715\ mm$

$m_{P3} = 0.4945\ mm$

$m_{P4} = 0.5278\ mm$

$m_{P5} = 0.5297\ mm$

$m_{P6} = 0.6371\ mm$

$m_{P7} = 0.5578\ mm$

$m_{P8} = 0.5563\ mm$

$m_{P9} = 0.8773\ mm$

•Elementi elipse grešaka

$$k = \sqrt{(Q_{xx} - Q_{yy})^2 + 4Q_{xy}^2} \qquad \lambda_1 = \frac{1}{2}(Q_{xx} + Q_{yy} + k) \qquad \lambda_2 = \frac{1}{2}(Q_{xx} + Q_{yy} - k)$$

$$c = \sigma_0\sqrt{\mathcal{X}^2_{1-\alpha,2}} \qquad A = c\sqrt{\lambda_1} \qquad B = c\sqrt{\lambda_2} \qquad tg\,2\theta = \frac{2Q_{xy}}{Q_{xx} - Q_{yy}}$$

$$A - velika\ poluosa\ elipse, \qquad B - mala\ poluosa\ elipse,$$

$$\theta - ugao\ koji\ velika\ poluosa\ A\ zaklapa\ sa\ pravcem\ severa$$

$A_{P1} = 1.1940\ mm$	$B_{P1} = 1.0285\ mm$	$\theta_{P1} = 346°\ 25'\ 16''$	$\frac{A_{P1}}{B_{P1}} = 1.1608$
$A_{P2} = 1.4712\ mm$	$B_{P2} = 0.7328\ mm$	$\theta_{P2} = 15°\ 31'\ 39''$	$\frac{A_{P2}}{B_{P2}} = 2.0076$
$A_{P3} = 1.0619\ mm$	$B_{P3} = 0.5811\ mm$	$\theta_{P3} = 15°\ 00'\ 50''$	$\frac{A_{P3}}{B_{P3}} = 1.8273$
$A_{P4} = 0.9982\ mm$	$B_{P4} = 0.8202\ mm$	$\theta_{P4} = 321°\ 18'\ 43''$	$\frac{A_{P4}}{B_{P4}} = 1.2170$
$A_{P5} = 1.0404\ mm$	$B_{P5} = 0.7738\ mm$	$\theta_{P5} = 14°\ 48'\ 14''$	$\frac{A_{P5}}{B_{P5}} = 1.3446$
$A_{P6} = 1.2516\ mm$	$B_{P6} = 0.9301\ mm$	$\theta_{P6} = 16°\ 36'\ 27''$	$\frac{A_{P6}}{B_{P6}} = 1.3456$
$A_{P7} = 1.1486\ mm$	$B_{P7} = 0.7380\ mm$	$\theta_{P7} = 339°\ 15'\ 33'$	$\frac{A_{P7}}{B_{P7}} = 1.5565$
$A_{P8} = 1.0570\ mm$	$B_{P8} = 0.8585\ mm$	$\theta_{P8} = 339°\ 09'\ 55'$	$\frac{A_{P8}}{B_{P8}} = 1.2312$
$A_{P9} = 1.9692\ mm$	$B_{P9} = 0.8564\ mm$	$\theta_{P9} = 07°\ 59'\ 05''$	$\frac{A_{P9}}{B_{P9}} = 2.2994$

•Matrica kofaktora popravaka Q_V $\quad Q_V = P^{-1} - AQ_xA^T$

Q_{Vdiag}

$= [\ 0.5315\ \ 0.5747\ \ 0.4376\ \ 0.4312\ \ 0.5620\ \ 0.4849\ \ 0.1956\ \ 0.5243\ \ 0.5045\ \ 0.4891$

$0.4275\ \ 0.5152\ \ 0.6285\ \ 0.5202\ \ 0.3867\ \ 0.1965\ \ 0.2198\ \ 0.4339\ \ 0.3244\ \ 0.2498$

$0.2498\ \ 0.2199\ \ 0.1663\ \ 0.3199\ \ 0.3111\ \ 0.4014\ \ 0.1393\ \ 1.0366\ \ 1.1913\ \ 1.0217$

$1.0217\ \ 1.1520\ \ 1.1520\ \ 1.0366\ \ 0.7573\ \ 0.9819\ \ 0.9173\ \ 0.6714\ \ 1.0683\ \ 0.7090$

$0.9596\ \ 0.9078\ \ 1.0290\ \ 0.7234\ \ 1.0290\ \ 0.6652\ ]$

• Koeficijenti unutrašnje pouzdanosti r_i

$$r_i = P_{ii}Q_{v_{ii}} \qquad r_i \geq 0.30 \Rightarrow Merenje\ je\ pouzdano$$

$r_1 = 0.5315$	$r_{24} = 0.3199$
$r_2 = 0.5747$	$r_{25} = 0.3111$
$r_3 = 0.4377$	$r_{26} = 0.4014$
$r_4 = 0.4312$	$\boldsymbol{r_{27} = 0.1393}$
$r_5 = 0.5620$	$r_{28} = 0.7168$
$r_6 = 0.4849$	$r_{29} = 0.6487$
$\boldsymbol{r_7 = 0.1956}$	$r_{30} = 0.7068$
$r_8 = 0.5243$	$r_{31} = 0.7068$
$r_9 = 0.5045$	$r_{32} = 0.7520$
$r_{10} = 0.4891$	$r_{33} = 0.7520$
$r_{11} = 0.4275$	$r_{34} = 0.7168$
$r_{12} = 0.5152$	$r_{35} = 0.4707$
$r_{13} = 0.6285$	$r_{36} = 0.6968$
$r_{14} = 0.5202$	$r_{37} = 0.6659$
$r_{15} = 0.3867$	$r_{38} = 0.5436$
$\boldsymbol{r_{16} = 0.1965}$	$r_{39} = 0.7500$
$\boldsymbol{r_{17} = 0.2198}$	$r_{40} = 0.5271$
$r_{18} = 0.4339$	$r_{41} = 0.7216$
$r_{19} = 0.3244$	$r_{42} = 0.6688$
$\boldsymbol{r_{20} = 0.2498}$	$r_{43} = 0.7347$
$\boldsymbol{r_{21} = 0.2498}$	$r_{44} = 0.5286$
$\boldsymbol{r_{22} = 0.2199}$	$r_{45} = 0.7347$
$\boldsymbol{r_{23} = 0.1663}$	$r_{46} = 0.5122$

•Marginalna gruba greška G_i koja se može otkriti *Data-snooping* testom

$$|G_i| = \frac{\sigma_0\sqrt{\lambda_0}}{P_i\sqrt{Q_{v_{ii}}}} \qquad |G_i| < 7\sigma_0 \qquad 7\sigma_0 = 4.9497$$

$$\lambda_0 = t_{1-\beta_0} + t_{1-\alpha/2} = 0{,}842 + 1{,}96 = 2.802$$

$G_1 = 1.4476$	$G_{17} = 0.9308$	$G_{32} = 3.2650$
$G_2 = 1.5052$	$G_{18} = 1.3079$	$G_{33} = 3.2650$
$G_3 = 1.3136$	$G_{19} = 1.1309$	$G_{34} = 2.9237$
$G_4 = 1.3038$	$G_{20} = 0.9923$	$G_{35} = 2.7798$
$G_5 = 1.4885$	$G_{21} = 0.9923$	$G_{36} = 2.7728$
$G_6 = 1.3826$	$G_{22} = 0.9311$	$G_{37} = 2.6196$
$G_7 = 0.8782$	$G_{23} = 0.8096$	$G_{38} = 2.0092$
$G_8 = 1.4377$	$G_{24} = 1.1230$	$G_{39} = 2.9232$
$G_9 = 1.4103$	$G_{25} = 1.1075$	$G_{40} = 2.2489$
$G_{10} = 1.3886$	$G_{26} = 1.2580$	$G_{41} = 2.5866$
$G_{11} = 1.2982$	$G_{27} = 0.7411$	$G_{42} = 2.5677$
$G_{12} = 1.4252$	$G_{28} = 2.9237$	$G_{43} = 2.8210$
$G_{13} = 1.5741$	$G_{29} = 3.9798$	$G_{44} = 2.3112$
$G_{14} = 1.4321$	$G_{30} = 2.9012$	$G_{45} = 2.8210$
$G_{15} = 1.2347$	$G_{31} = 2.9012$	$G_{46} = 2.1033$
$G_{16} = 0.8801$		

ZADATAK 2

a)

•Plan opažanja

Plan opazanja		
od	do	S[km]
P2	P1	0,283
P3	P2	0,308
P3	P1	0,296
P1	P4	0,269
P4	P3	0,281
P5	P4	0,45
P6	P5	0,291
P3	P6	0,454
P5	P8	0,32
P6	P8	0,362
P7	P6	0,35
P7	P8	0,354

•Funkcije veze

$$\Delta h_{p2-p1} = H_{P1} - H_{P2} \qquad \Delta h_{p6-p5} = H_{P5} - H_{P6}$$

$$\Delta h_{p3-p2} = H_{P3} - H_{P2} \qquad \Delta h_{p3-p6} = H_{P6} - H_{P3}$$

$$\Delta h_{p3-p1} = H_{P1} - H_{P3} \qquad \Delta h_{p5-p8} = H_{P8} - H_{P5}$$

$$\Delta h_{p1-p4} = H_{P4} - H_{P1} \qquad \Delta h_{p6-p8} = H_{P8} - H_{P6}$$

$$\Delta h_{p4-p3} = H_{P3} - H_{P4} \qquad \Delta h_{p7-p6} = H_{P6} - H_{P7}$$

$$\Delta h_{p5-p4} = H_{P4} - H_{P5} \qquad \Delta h_{p7-p8} = H_{P8} - H_{P7}$$

•Jednačine popravaka

$$v_{\Delta h_{p2-p1}} = \Delta H_{P1} - \Delta H_{P2} + f_{\Delta h_{p2-p1}} \qquad v_{\Delta h_{p6-p5}} = \Delta H_{P5} - \Delta H_{P6} + f_{\Delta h_{p6-p5}}$$

$$v_{\Delta h_{p3-p2}} = \Delta H_{P2} - \Delta H_{P3} + f_{\Delta h_{p3-p2}} \qquad v_{\Delta h_{p3-p6}} = \Delta H_{P6} - \Delta H_{P3} + f_{\Delta h_{p3-p6}}$$

$$v_{\Delta h_{p3-p1}} = \Delta H_{P1} - \Delta H_{P3} + f_{\Delta h_{p3-p1}} \qquad v_{\Delta h_{p5-p8}} = \Delta H_{P8} - \Delta H_{P5} + f_{\Delta h_{p5-p8}}$$

$$v_{\Delta h_{p1-p4}} = \Delta H_{P4} - \Delta H_{P1} + f_{\Delta h_{p1-p4}} \qquad v_{\Delta h_{p6-p8}} = \Delta H_{P8} - \Delta H_{P6} + f_{\Delta h_{p6-p8}}$$

$$v_{\Delta h_{p4-p3}} = \Delta H_{P3} - \Delta H_{P4} + f_{\Delta h_{p4-p3}} \qquad v_{\Delta h_{p7-p6}} = \Delta H_{P6} - \Delta H_{P7} + f_{\Delta h_{p7-p6}}$$

$$v_{\Delta h_{p5-p4}} = \Delta H_{P4} - \Delta H_{P5} + f_{\Delta h_{p5-p4}} \qquad v_{\Delta h_{p7-p8}} = \Delta H_{P8} - \Delta H_{P7} + f_{\Delta h_{p7-p8}}$$

•Matrica dizajna A

$$A = \begin{array}{c} \begin{array}{cccccccc} \text{H1} & \text{H2} & \text{H3} & \text{H4} & \text{H5} & \text{H6} & \text{H7} & \text{H8} \end{array} \\ \left|\begin{array}{cccccccc} 1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & -1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 \end{array}\right| \end{array}$$

•Homogenizacija težina

$$\sigma_{\Delta h0} = 0.95\frac{mm}{\sqrt{km}} \qquad \sigma_{\Delta h_i} = \sigma_{\Delta h0} \cdot \sqrt{D_i}$$

$$P_{\Delta h_{i-j}} = \frac{\sigma_0^2}{\sigma_{\Delta h_{i-j}}^2} = \frac{c}{\sigma_{\Delta h_i - j}^2} \ , \ \sigma_0^2 = 1^2 = 1$$

$\sigma_{\Delta h_{p2-p1}} = 0.5054\ mm$ $\qquad$ $\sigma_{\Delta h_{p5-p4}} = 0.5125mm$

$\sigma_{\Delta h_{p3-p2}} = 0.5272mm$ $\qquad$ $\sigma_{\Delta h_{p5-p4}} = 0.6401\ mm$

$\sigma_{\Delta h_{p3-p1}} = 0.5169\ mm$ $\qquad$ $\sigma_{\Delta h_{p5-p4}} = 0.5374\ mm$

$\sigma_{\Delta h_{p1-p4}} = 0.4927\ mm$ $\qquad$ $\sigma_{\Delta h_{p5-p4}} = 0.5716\ mm$

$\sigma_{\Delta h_{p4-p3}} = 0.5036\ mm$ $\qquad$ $\sigma_{\Delta h_{p5-p4}} = 0.5620\ mm$

$\sigma_{\Delta h_{p5-p4}} = 0.6373\ mm$ $\qquad$ $\sigma_{\Delta h_{p5-p4}} = 0.5652\ mm$

•Matrica težina P

$$P = \begin{vmatrix} 3{,}9153 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 3{,}5975 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 3{,}7434 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 4{,}1191 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 3{,}943 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2{,}462296 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 3{,}80767 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 2{,}441 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 3{,}463 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 3{,}0609 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 3{,}1658 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 3{,}13 \end{vmatrix}$$

•Matrica koeficijenata normalnih jednačina N $\quad N = A^T PA$

$$N = \begin{vmatrix} 11,778 & -3,915 & -3,743 & -4,119 & 0 & 0 & 0 & 0 \\ -3,9153 & 7,5128 & -3,598 & 0 & 0 & 0 & 0 & 0 \\ -3,7434 & -3,598 & 13,725 & -3,943 & 0 & -2,4406 & 0 & 0 \\ -4,1191 & 0 & -3,943 & 10,525 & -2,46 & 0 & 0 & 0 \\ 0 & 0 & 0 & -2,462 & 9,733 & -3,80767 & 0 & -3,463 \\ 0 & 0 & -2,441 & 0 & -3,81 & 12,47495 & -3,1658 & -3,061 \\ 0 & 0 & 0 & 0 & 0 & -3,16581 & 6,29585 & -3,13 \\ 0 & 0 & 0 & 0 & -3,46 & -3,06087 & -3,13 & 9,654 \end{vmatrix}$$

•Matrica datumskih uslova R

Datum je definisan na klasičan način.

$$R^T = \begin{array}{|cccccccc|} H1 & H2 & H3 & H4 & H5 & H6 & H7 & H8 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{array}$$

•Matrica koeficijenata normalnih jednačina N proširena matricom datumskih uslova R

$$\begin{bmatrix} N & R \\ R^T & 0 \end{bmatrix}$$

$$\begin{bmatrix} N & R \\ R^T & 0 \end{bmatrix} = \left|\begin{array}{cccccccc|c} 11,778 & -3,915 & -3,743 & -4,119 & 0 & 0 & 0 & 0 & 1 \\ -3,9153 & 7,5128 & -3,598 & 0 & 0 & 0 & 0 & 0 & 0 \\ -3,7434 & -3,598 & 13,725 & -3,943 & 0 & -2,4406 & 0 & 0 & 0 \\ -4,1191 & 0 & -3,943 & 10,525 & -2,46 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -2,462 & 9,733 & -3,80767 & 0 & -3,463 & 0 \\ 0 & 0 & -2,441 & 0 & -3,81 & 12,47495 & -3,1658 & -3,061 & 0 \\ 0 & 0 & 0 & 0 & 0 & -3,16581 & 6,29585 & -3,13 & 0 \\ 0 & 0 & 0 & 0 & -3,46 & -3,06087 & -3,13 & 9,654 & 0 \\ \hline 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{array}\right|$$

•Matrica kofaktora nepoznatih parametara $N^- = Q_x$ $\begin{bmatrix} N^- & R^- \\ R^{T-} & 0^- \end{bmatrix}$

$$\begin{bmatrix} N^- & R^- \\ R^{T-} & 0^- \end{bmatrix} = \left[\begin{array}{cccccccc|c} 0 & -9E\text{-}17 & -9E\text{-}17 & -3E\text{-}17 & -0 & -1{,}9E\text{-}17 & -5E\text{-}17 & -1E\text{-}16 & 1 \\ 0 & 0{,}1623 & 0{,}0609 & 0{,}0332 & 0{,}045 & 0{,}049413 & 0{,}04839 & 0{,}047 & 1 \\ 0 & 0{,}0609 & 0{,}1271 & 0{,}0694 & 0{,}093 & 0{,}103192 & 0{,}10105 & 0{,}099 & 1 \\ 0 & 0{,}0332 & 0{,}0694 & 0{,}1481 & 0{,}116 & 0{,}102025 & 0{,}10495 & 0{,}108 & 1 \\ 0 & 0{,}0446 & 0{,}0931 & 0{,}1158 & 0{,}346 & 0{,}270829 & 0{,}28676 & 0{,}303 & 1 \\ 0 & 0{,}0494 & 0{,}1032 & 0{,}102 & 0{,}271 & 0{,}342622 & 0{,}32736 & 0{,}312 & 1 \\ 0 & 0{,}0484 & 0{,}101 & 0{,}1049 & 0{,}287 & 0{,}327359 & 0{,}50809 & 0{,}371 & 1 \\ 0 & 0{,}0473 & 0{,}0989 & 0{,}1079 & 0{,}303 & 0{,}311922 & 0{,}37139 & 0{,}432 & 1 \\ \hline 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & -0 \end{array}\right]$$

•Standardno odstupanje nepozatih parametara

$$m_{Hi} = \sigma_0 \cdot \sqrt{Q_{x_{ii}}}$$

$$m_{H1} = 0.0000\,mm \qquad m_{H5} = 0.5880\,mm$$

$$m_{H2} = 0.4028\,mm \qquad m_{H6} = 0.5853\,mm$$

$$m_{H3} = 0.3565\,mm \qquad m_{H7} = 0.7128\,mm$$

$$m_{H4} = 0.3848\,mm \qquad m_{H8} = 0.6569\,mm$$

•Matrica kofaktora popravaka $Q_V = \quad Q_v = P^{-1} - AQ_xA^T$

$$Q_V = \begin{bmatrix} 0{,}0932 & 0{,}1014 & -0{,}061 & 0{,}0332 & 0{,}028 & -0{,}0114 & -0{,}0048 & -0{,}012 & 0{,}003 & -0{,}002 & 0{,}001 & -0{,}001 \\ 0{,}1014 & 0{,}1103 & -0{,}066 & 0{,}0362 & 0{,}03 & -0{,}0124 & -0{,}0053 & -0{,}013 & 0{,}003 & -0{,}002 & 0{,}0011 & -0{,}0011 \\ -0{,}0609 & -0{,}066 & 0{,}14 & 0{,}0694 & 0{,}058 & -0{,}0237 & -0{,}0101 & -0{,}024 & 0{,}006 & -0{,}004 & 0{,}0021 & -0{,}0022 \\ 0{,}0332 & 0{,}0362 & 0{,}0694 & 0{,}0947 & 0{,}079 & -0{,}0323 & -0{,}0138 & -0{,}033 & 0{,}008 & -0{,}006 & 0{,}0029 & -0{,}003 \\ 0{,}0276 & 0{,}0301 & 0{,}0577 & 0{,}0787 & 0{,}117 & 0{,}056 & 0{,}0238 & 0{,}057 & -0{,}01 & 0{,}0102 & -0{,}005 & 0{,}0051 \\ -0{,}0114 & -0{,}012 & -0{,}024 & -0{,}032 & 0{,}056 & 0{,}1438 & 0{,}0612 & 0{,}145 & -0{,}04 & 0{,}0262 & -0{,}013 & 0{,}0132 \\ -0{,}0048 & -0{,}005 & -0{,}01 & -0{,}014 & 0{,}024 & 0{,}0612 & 0{,}1159 & 0{,}062 & 0{,}084 & -0{,}063 & 0{,}0312 & -0{,}0315 \\ -0{,}0115 & -0{,}013 & -0{,}024 & -0{,}033 & 0{,}057 & 0{,}1451 & 0{,}0617 & 0{,}146 & -0{,}04 & 0{,}0264 & -0{,}013 & 0{,}0133 \\ 0{,}0028 & 0{,}003 & 0{,}0058 & 0{,}0079 & -0{,}01 & -0{,}035 & 0{,}084 & -0{,}035 & 0{,}117 & -0{,}088 & 0{,}0435 & -0{,}044 \\ -0{,}0021 & -0{,}002 & -0{,}004 & -0{,}006 & 0{,}01 & 0{,}0262 & -0{,}0627 & 0{,}026 & -0{,}09 & 0{,}1764 & 0{,}0747 & -0{,}0756 \\ 0{,}001 & 0{,}0011 & 0{,}0021 & 0{,}0029 & -0{,}01 & -0{,}013 & 0{,}0312 & -0{,}013 & 0{,}044 & 0{,}0747 & 0{,}1199 & -0{,}1213 \\ -0{,}001 & -0{,}001 & -0{,}002 & -0{,}003 & 0{,}005 & 0{,}0132 & -0{,}0315 & 0{,}013 & -0{,}04 & -0{,}076 & -0{,}121 & 0{,}1226 \end{bmatrix}$$

• Koeficijenti unutrašnje pouzdanosti r_i

$$r_i = P_{ii}Q_{v_{ii}} \qquad r_i \geq 0.30 \Rightarrow Merenje\ je\ pouzdano$$

$$r_1 = 0.3649 \qquad r_7 = 0.4413$$
$$r_2 = 0.3968 \qquad r_8 = 0.3573$$
$$r_3 = 0.5241 \qquad r_9 = 0.4058$$
$$r_4 = 0.3901 \qquad r_{10} = 0.5399$$
$$r_5 = 0.4621 \qquad r_{11} = 0.3796$$
$$r_6 = 0.3541 \qquad r_{12} = 0.3837$$

•Marginalna gruba greška G_i koja se može otkriti *Data-snooping* testom

$$|G_i| = \frac{\sigma_0\sqrt{\lambda_0}}{P_i\sqrt{Q_{v_{ii}}}} \qquad \sigma_0 = 1$$

$$\lambda_0 = t_{1-\beta_0} + t_{1-\alpha/2} = 0{,}842 + 1{,}96 = 2{,}802$$

$$G_1 = 2.3442 \qquad G_7 = 2.1616$$
$$G_2 = 2.3452 \qquad G_8 = 3.0005$$
$$G_3 = 2.0005 \qquad G_9 = 2.3637$$
$$G_4 = 2.2105 \qquad G_{10} = 2.1796$$
$$G_5 = 2.0757 \qquad G_{11} = 2.5561$$
$$G_6 = 3.0009 \qquad G_{12} = 2.5567$$

b)

•Plan opažanja

Plan opazanja		
od	do	S[km]
P2	P1	0,283
P3	P2	0,308
P3	P1	0,296
P1	P4	0,269
P4	P3	0,281
P5	P4	0,45
P6	P5	0,291
P3	P6	0,454
P5	P8	0,32
P6	P8	0,362
P7	P6	0,35
P7	P8	0,354

•Funkcije veze

$$\Delta h_{p2-p1} = H_{P1} - H_{P2} \qquad \Delta h_{p6-p5} = H_{P5} - H_{P6}$$

$$\Delta h_{p3-p2} = H_{P3} - H_{P2} \qquad \Delta h_{p3-p6} = H_{P6} - H_{P3}$$

$$\Delta h_{p3-p1} = H_{P1} - H_{P3} \qquad \Delta h_{p5-p8} = H_{P8} - H_{P5}$$

$$\Delta h_{p1-p4} = H_{P4} - H_{P1} \qquad \Delta h_{p6-p8} = H_{P8} - H_{P6}$$

$$\Delta h_{p4-p3} = H_{P3} - H_{P4} \qquad \Delta h_{p7-p6} = H_{P6} - H_{P7}$$

$$\Delta h_{p5-p4} = H_{P4} - H_{P5} \qquad \Delta h_{p7-p8} = H_{P8} - H_{P7}$$

•Jednačine popravaka

$$v_{\Delta h_{p2-p1}} = \Delta H_{P1} - \Delta H_{P2} + f_{\Delta h_{p2-p1}} \qquad v_{\Delta h_{p6-p5}} = \Delta H_{P5} - \Delta H_{P6} + f_{\Delta h_{p6-p5}}$$

$$v_{\Delta h_{p3-p2}} = \Delta H_{P2} - \Delta H_{P3} + f_{\Delta h_{p3-p2}} \qquad v_{\Delta h_{p3-p6}} = \Delta H_{P6} - \Delta H_{P3} + f_{\Delta h_{p3-p6}}$$

$$v_{\Delta h_{p3-p1}} = \Delta H_{P1} - \Delta H_{P3} + f_{\Delta h_{p3-p1}} \qquad v_{\Delta h_{p5-p8}} = \Delta H_{P8} - \Delta H_{P5} + f_{\Delta h_{p5-p8}}$$

$$v_{\Delta h_{p1-p4}} = \Delta H_{P4} - \Delta H_{P1} + f_{\Delta h_{p1-p4}} \qquad v_{\Delta h_{p6-p8}} = \Delta H_{P8} - \Delta H_{P6} + f_{\Delta h_{p6-p8}}$$

$$v_{\Delta h_{p4-p3}} = \Delta H_{P3} - \Delta H_{P4} + f_{\Delta h_{p4-p3}} \qquad v_{\Delta h_{p7-p6}} = \Delta H_{P6} - \Delta H_{P7} + f_{\Delta h_{p7-p6}}$$

$$v_{\Delta h_{p5-p4}} = \Delta H_{P4} - \Delta H_{P5} + f_{\Delta h_{p5-p4}} \qquad v_{\Delta h_{p7-p8}} = \Delta H_{P8} - \Delta H_{P7} + f_{\Delta h_{p7-p8}}$$

•Matrica dizajna A

$$A = \begin{array}{c} \begin{array}{cccccccc} \text{H1} & \text{H2} & \text{H3} & \text{H4} & \text{H5} & \text{H6} & \text{H7} & \text{H8} \end{array} \\ \left|\begin{array}{cccccccc} 1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & -1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 \end{array}\right| \end{array}$$

•Homogenizacija težina

$$\sigma_{\Delta h0} = 0.95\frac{mm}{\sqrt{km}} \qquad \sigma_{\Delta h_i} = \sigma_{\Delta h0} \cdot \sqrt{D_i}$$

$$P_{\Delta h_{i-j}} = \frac{\sigma_0^2}{\sigma_{\Delta h_{i-j}}^2} = \frac{c}{\sigma_{\Delta h_i - j}^2} \ , \ \sigma_0^2 = 1^2 = 1$$

$\sigma_{\Delta h_{p2-p1}} = 0.5054\ mm$ $\qquad$ $\sigma_{\Delta h_{p5-p4}} = 0.5125mm$

$\sigma_{\Delta h_{p3-p2}} = 0.5272mm$ $\qquad$ $\sigma_{\Delta h_{p5-p4}} = 0.6401\ mm$

$\sigma_{\Delta h_{p3-p1}} = 0.5169\ mm$ $\qquad$ $\sigma_{\Delta h_{p5-p4}} = 0.5374\ mm$

$\sigma_{\Delta h_{p1-p4}} = 0.4927\ mm$ $\qquad$ $\sigma_{\Delta h_{p5-p4}} = 0.5716\ mm$

$\sigma_{\Delta h_{p4-p3}} = 0.5036\ mm$ $\qquad$ $\sigma_{\Delta h_{p5-p4}} = 0.5620\ mm$

$\sigma_{\Delta h_{p5-p4}} = 0.6373\ mm$ $\qquad$ $\sigma_{\Delta h_{p5-p4}} = 0.5652\ mm$

•Matrica težina P

$$P = \begin{vmatrix} 3{,}9153 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 3{,}5975 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 3{,}7434 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 4{,}1191 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 3{,}943 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 2{,}462296 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 3{,}80767 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 2{,}441 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 3{,}463 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 3{,}0609 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 3{,}1658 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 3{,}13 \end{vmatrix}$$

•Matrica koeficijenata normalnih jednačina N $\quad N = A^T PA$

$$N = \begin{vmatrix} 11,778 & -3,915 & -3,743 & -4,119 & 0 & 0 & 0 & 0 \\ -3,9153 & 7,5128 & -3,598 & 0 & 0 & 0 & 0 & 0 \\ -3,7434 & -3,598 & 13,725 & -3,943 & 0 & -2,4406 & 0 & 0 \\ -4,1191 & 0 & -3,943 & 10,525 & -2,46 & 0 & 0 & 0 \\ 0 & 0 & 0 & -2,462 & 9,733 & -3,80767 & 0 & -3,463 \\ 0 & 0 & -2,441 & 0 & -3,81 & 12,47495 & -3,1658 & -3,061 \\ 0 & 0 & 0 & 0 & 0 & -3,16581 & 6,29585 & -3,13 \\ 0 & 0 & 0 & 0 & -3,46 & -3,06087 & -3,13 & 9,654 \end{vmatrix}$$

•Matrica datumskih uslova B

Datum je definisan minimalnim tragom na sve tačke.

$$B^T = \begin{vmatrix} H1 & H2 & H3 & H4 & H5 & H6 & H7 & H8 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{vmatrix}$$

•Matrica koeficijenata normalnih jednačina N proširena matricom datumskih uslova B

$$\begin{bmatrix} N & B \\ B^T & 0 \end{bmatrix}$$

$$\begin{bmatrix} N & B \\ B^T & 0 \end{bmatrix} = \left|\begin{array}{cccccccc|c} 11,778 & -3,915 & -3,743 & -4,119 & 0 & 0 & 0 & 0 & 1 \\ -3,9153 & 7,5128 & -3,598 & 0 & 0 & 0 & 0 & 0 & 1 \\ -3,7434 & -3,598 & 13,725 & -3,943 & 0 & -2,4406 & 0 & 0 & 1 \\ -4,1191 & 0 & -3,943 & 10,525 & -2,46 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & -2,462 & 9,733 & -3,80767 & 0 & -3,463 & 1 \\ 0 & 0 & -2,441 & 0 & -3,81 & 12,47495 & -3,1658 & -3,061 & 1 \\ 0 & 0 & 0 & 0 & 0 & -3,16581 & 6,29585 & -3,13 & 1 \\ 0 & 0 & 0 & 0 & -3,46 & -3,06087 & -3,13 & 9,654 & 1 \\ \hline 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 \end{array}\right|$$

•Matrica kofaktora nepoznatih parametara $N^+ = Q_x$ $\begin{bmatrix} N^+ & B^+ \\ B^{T+} & 0^+ \end{bmatrix}$

$$\begin{bmatrix} N^+ & B^+ \\ B^{T+} & 0^+ \end{bmatrix} = \left[\begin{array}{cccccccc|c} 0{,}1276 & 0{,}0719 & 0{,}0459 & 0{,}0424 & -0{,}05 & -0{,}0608 & -0{,}0909 & -0{,}081 & 0{,}125 \\ 0{,}0719 & 0{,}1784 & 0{,}051 & 0{,}0199 & -0{,}07 & -0{,}06714 & -0{,}0982 & -0{,}09 & 0{,}125 \\ 0{,}0459 & 0{,}051 & 0{,}0913 & 0{,}0302 & -0{,}04 & -0{,}03931 & -0{,}0715 & -0{,}064 & 0{,}125 \\ 0{,}0424 & 0{,}0199 & 0{,}0302 & 0{,}1054 & -0{,}02 & -0{,}04395 & -0{,}0711 & -0{,}059 & 0{,}125 \\ -0{,}0548 & -0{,}066 & -0{,}043 & -0{,}024 & 0{,}108 & 0{,}027575 & 0{,}01342 & 0{,}039 & 0{,}125 \\ -0{,}0608 & -0{,}067 & -0{,}039 & -0{,}044 & 0{,}028 & 0{,}093406 & 0{,}04807 & 0{,}042 & 0{,}125 \\ -0{,}0909 & -0{,}098 & -0{,}072 & -0{,}071 & 0{,}013 & 0{,}048066 & 0{,}19872 & 0{,}072 & 0{,}125 \\ -0{,}0814 & -0{,}09 & -0{,}064 & -0{,}059 & 0{,}039 & 0{,}042143 & 0{,}07154 & 0{,}141 & 0{,}125 \\ \hline 0{,}125 & 0{,}125 & 0{,}125 & 0{,}125 & 0{,}125 & 0{,}125 & 0{,}125 & 0{,}125 & -0 \end{array}\right]$$

•Standardno odstupanje nepozatih parametara

$$m_{Hi} = \sigma_0 \cdot \sqrt{Q_{x_{ii}}}$$

$$m_{H1} = 0.3572\,mm \qquad m_{H5} = 0.3293\,mm$$

$$m_{H2} = 0.4223\,mm \qquad m_{H6} = 0.3056\,mm$$

$$m_{H3} = 0.3022\,mm \qquad m_{H7} = 0.4458\,mm$$

$$m_{H4} = 0.3246\,mm \qquad m_{H8} = 0.3758\,mm$$

•Matrica kofaktora popravaka Q_V $Q_V = P^{-1} - AQ_xA^T$

$$Q_v = \begin{bmatrix} 0{,}0932 & 0{,}1014 & -0{,}061 & 0{,}0332 & 0{,}028 & -0{,}01135 & -0{,}0048 & -0{,}011 & 0{,}003 & -0{,}002 & 0{,}001 & -0{,}001 \\ 0{,}1014 & 0{,}1103 & -0{,}066 & 0{,}0362 & 0{,}03 & -0{,}01235 & -0{,}0053 & -0{,}012 & 0{,}003 & -0{,}002 & 0{,}0011 & -0{,}001 \\ -0{,}0609 & -0{,}066 & 0{,}14 & 0{,}0694 & 0{,}058 & -0{,}0237 & -0{,}0101 & -0{,}024 & 0{,}006 & -0{,}004 & 0{,}0021 & -0{,}002 \\ 0{,}0332 & 0{,}0362 & 0{,}0694 & 0{,}0947 & 0{,}079 & -0{,}03233 & -0{,}0138 & -0{,}033 & 0{,}008 & -0{,}006 & 0{,}0029 & -0{,}003 \\ 0{,}0276 & 0{,}0301 & 0{,}0577 & 0{,}0787 & 0{,}117 & 0{,}056035 & 0{,}02383 & 0{,}057 & -0{,}01 & 0{,}0102 & -0{,}005 & 0{,}0051 \\ -0{,}0114 & -0{,}012 & -0{,}024 & -0{,}032 & 0{,}056 & 0{,}143822 & 0{,}06117 & 0{,}145 & -0{,}04 & 0{,}0262 & -0{,}013 & 0{,}0132 \\ -0{,}0048 & -0{,}005 & -0{,}01 & -0{,}014 & 0{,}024 & 0{,}061167 & 0{,}11592 & 0{,}062 & 0{,}084 & -0{,}063 & 0{,}0312 & -0{,}032 \\ -0{,}0115 & -0{,}012 & -0{,}024 & -0{,}033 & 0{,}057 & 0{,}1451 & 0{,}06171 & 0{,}146 & -0{,}04 & 0{,}0264 & -0{,}013 & 0{,}0133 \\ 0{,}0028 & 0{,}003 & 0{,}0058 & 0{,}0079 & -0{,}01 & -0{,}03501 & 0{,}08397 & -0{,}035 & 0{,}117 & -0{,}088 & 0{,}0435 & -0{,}044 \\ -0{,}0021 & -0{,}002 & -0{,}004 & -0{,}006 & 0{,}01 & 0{,}026156 & -0{,}0627 & 0{,}026 & -0{,}09 & 0{,}1764 & 0{,}0747 & -0{,}076 \\ 0{,}001 & 0{,}0011 & 0{,}0021 & 0{,}0029 & -0{,}01 & -0{,}013 & 0{,}03119 & -0{,}013 & 0{,}044 & 0{,}0747 & 0{,}1199 & -0{,}121 \\ -0{,}001 & -0{,}001 & -0{,}002 & -0{,}003 & 0{,}005 & 0{,}013152 & -0{,}0315 & 0{,}013 & -0{,}04 & -0{,}076 & -0{,}121 & 0{,}1226 \end{bmatrix}$$

• Koeficijenti unutrašnje pouzdanosti r_i

$$r_i = P_{ii}Q_{v_{ii}} \qquad r_i \geq 0.30 \Rightarrow Merenje\ je\ pouzdano$$

$$r_1 = 0.3647 \qquad r_7 = 0.4414$$
$$r_2 = 0.3970 \qquad r_8 = 0.3573$$
$$r_3 = 0.5242 \qquad r_9 = 0.4060$$
$$r_4 = 0.3899 \qquad r_{10} = 0.5399$$
$$r_5 = 0.4622 \qquad r_{11} = 0.3795$$
$$r_6 = 0.3541 \qquad r_{12} = 0.3839$$

•Marginalna gruba greška G_i koja se može otkriti *Data-snooping* testom

$$|G_i| = \frac{\sigma_0\sqrt{\lambda_0}}{P_i\sqrt{Q_{v_{ii}}}} \qquad \sigma_0 = 1$$

$$\lambda_0 = t_{1-\beta_0} + t_{1-\alpha/2} = 0{,}842 + 1{,}96 = 2{,}802$$

$$G_1 = 2.3447 \qquad G_7 = 2.1614$$
$$G_2 = 2.3447 \qquad G_8 = 3.0006$$
$$G_3 = 2.0003 \qquad G_9 = 2.3634$$
$$G_4 = 2.2109 \qquad G_{10} = 2.1797$$
$$G_5 = 2.0757 \qquad G_{11} = 2.5562$$
$$G_6 = 3.0006 \qquad G_{12} = 2.5562$$

ZADATAK 3

•Matrica težina P

$$A = E \quad E - jedinična\ matrica$$

$$N = A^T PA \qquad N = P$$

$$P_{xi} = \frac{\sigma_0}{\sigma_{xi}} \qquad P_{yi} = \frac{\sigma_0}{\sigma_{yi}} \qquad \sigma_0 = 1$$

$$P = \begin{vmatrix} 0{,}147929 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0{,}127551 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0{,}147929 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0{,}127551 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0{,}147929 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0{,}127551 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0{,}147929 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0{,}127551 \end{vmatrix}$$

•Matrica kofaktora nepoznatih parametara Q_x $\qquad Q_x = N^{-1}$

$$Q_x = \begin{vmatrix} 6{,}76 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 7{,}84 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 6{,}76 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 7{,}84 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 6{,}76 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 7{,}84 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 6{,}76 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 7{,}84 \end{vmatrix}$$

•Postavljanje hipoteza

$$H_0: Obeležena\ figura\ \ je\ kvadrat.$$

$$H_a: Obeležena\ figura\ nije\ kvadrat.$$

$$H_0:\ M\begin{bmatrix} d_{P1-P2} - d_{P2-P3} \\ d_{P2-P3} - d_{P3-P4} \\ d_{P3-P4} - d_{P4-P1} \\ \nu_{P1}^{P4} - \nu_{P1}^{P2} - 90° \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \qquad H_a:\ M\begin{bmatrix} d_{P1-P2} - d_{P2-P3} \\ d_{P2-P3} - d_{P3-P4} \\ d_{P3-P4} - d_{P4-P1} \\ \nu_{P1}^{P4} - \nu_{P1}^{P2} - 90° \end{bmatrix} \neq \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

•Funkcije veze

$$L_1: d_{P1-P2} - d_{P2-P3} = \sqrt{[(Y_{P2} - Y_{P1})^2 + (X_{P2} - X_{P1})^2]} - \sqrt{[(Y_{P3} - Y_{P2})^2 + (X_{P3} - X_{P2})^2]}$$

$$L_2: d_{P2-P3} - d_{P3-P4} = \sqrt{[(Y_{P3} - Y_{P2})^2 + (X_{P3} - X_{P2})^2]} - \sqrt{[(Y_{P4} - Y_{P3})^2 + (X_{P4} - X_{P3})^2]}$$

$$L_3: d_{P3-P4} - d_{P4-P1} = \sqrt{[(Y_{P4} - Y_{P3})^2 + (X_{P4} - X_{P3})^2]} - \sqrt{[(Y_{P1} - Y_{P4})^2 + (X_{P1} - X_{P4})^2]}$$

$$L_4: \nu_{P1}^{P4} - \nu_{P1}^{P2} - 90° = \tan^{-1}\frac{Y_{P4} - Y_{P1}}{X_{P4} - X_{P1}} - \tan^{-1}\frac{Y_{P2} - Y_{P1}}{X_{P2} - X_{P1}} - 90°$$

•Matrica koeficijenata H

$$H = \begin{vmatrix} \frac{\partial L_1}{\partial X_{P1}} & \frac{\partial L_1}{\partial Y_{P1}} & \frac{\partial L_1}{\partial X_{P2}} & \frac{\partial L_1}{\partial Y_{P2}} & \frac{\partial L_1}{\partial X_{P3}} & \frac{\partial L_1}{\partial Y_{P3}} & \frac{\partial L_1}{\partial X_{P4}} & \frac{\partial L_1}{\partial Y_{P4}} \\ \frac{\partial L_2}{\partial X_{P1}} & \frac{\partial L_2}{\partial Y_{P1}} & \frac{\partial L_2}{\partial X_{P2}} & \frac{\partial L_2}{\partial Y_{P2}} & \frac{\partial L_2}{\partial X_{P3}} & \frac{\partial L_2}{\partial Y_{P3}} & \frac{\partial L_2}{\partial X_{P4}} & \frac{\partial L_2}{\partial Y_{P4}} \\ \frac{\partial L_3}{\partial X_{P1}} & \frac{\partial L_3}{\partial Y_{P1}} & \frac{\partial L_3}{\partial X_{P2}} & \frac{\partial L_3}{\partial Y_{P2}} & \frac{\partial L_3}{\partial X_{P3}} & \frac{\partial L_3}{\partial Y_{P3}} & \frac{\partial L_3}{\partial X_{P4}} & \frac{\partial L_3}{\partial Y_{P4}} \\ \frac{\partial L_4}{\partial X_{P1}} & \frac{\partial L_4}{\partial Y_{P1}} & \frac{\partial L_4}{\partial X_{P2}} & \frac{\partial L_4}{\partial Y_{P2}} & \frac{\partial L_4}{\partial X_{P3}} & \frac{\partial L_4}{\partial Y_{P3}} & \frac{\partial L_4}{\partial X_{P4}} & \frac{\partial L_4}{\partial Y_{P4}} \end{vmatrix}$$

$$H = \begin{array}{|cccccccc|} \text{XP1} & \text{YP1} & \text{XP2} & \text{YP2} & \text{XP3} & \text{YP3} & \text{XP4} & \text{YP4} \\ -0{,}89372 & -0{,}44862 & 0{,}445029 & 1{,}3423 & 0{,}448695 & -0{,}89368 & 0 & 0 \\ 0 & 0 & 0{,}448695 & -0{,}89368 & -1{,}34246 & 0{,}445149 & 0{,}893765 & 0{,}4485353 \\ -0{,}44864 & 0{,}893713 & 0 & 0 & 0{,}893765 & 0{,}448535 & -0{,}44513 & -1{,}342249 \\ 0{,}766298 & 2{,}31108 & 0{,}772359 & -1{,}53868 & 0 & 0 & -1{,}53866 & -0{,}772397 \end{array}$$

•Vektor odstupanja d

$$d = \begin{bmatrix} d_{P1-P2} - d_{P2-P3} \\ d_{P2-P3} - d_{P3-P4} \\ d_{P3-P4} - d_{P4-P1} \\ \nu_{P1}^{P4} - \nu_{P1}^{P2} - 90° \end{bmatrix} \qquad d = \begin{vmatrix} 10{,}26859 \\ -2{,}64962 \\ -8{,}07113 \\ 5{,}388385 \end{vmatrix}$$

•Matrica Q_d $\quad Q_d = HQ_xH^T$

$$Q_d = \begin{vmatrix} 30{,}06462 & -15{,}2458 & -0{,}86454 & -26{,}627 \\ -15{,}245814 & 28{,}33628 & -13{,}955 & 1{,}110987 \\ -0{,}8645371 & -13{,}955 & 30{,}0641 & 26{,}62706 \\ -26{,}627026 & 1{,}110987 & 26{,}62706 & 89{,}11928 \end{vmatrix}$$

•Matrica Q_d^{-1}

$$Q_d^{-1} = \begin{vmatrix} 0{,}070209 & 0{,}037997 & 0{,}002036 & 0{,}019895 \\ 0{,}037997 & 0{,}072948 & 0{,}034953 & 8{,}15E\text{-}08 \\ 0{,}002036 & 0{,}034953 & 0{,}067166 & -0{,}0199 \\ 0{,}019895 & 8{,}15E\text{-}08 & -0{,}0199 & 0{,}02311 \end{vmatrix}$$

•Test statistika

$$T = \frac{d^T Q_d^{-1} d}{k\sigma_0^2} \approx F_{0.95}(k, \infty)$$

$$k - rang\ matrice\ H\ , \qquad F_{0.95}(k, \infty) - kvantil\ Fišerovog\ rasporeda$$

$$k = rang(H) = 4$$

$$T = 3.9959 \quad > \quad F_{0.95}(4, \infty) = 2.3728$$

ZAKLJUČAK:

Nulta hipoteza H_0 se odbacuje. Prihvata se alternativna hipoteza H_a: obeležena figura nije kvadrat.

ZADATAK 4

•Matrica kofaktora nepoznatih parametara Q_x

$$P_i = \frac{\sigma_0^2}{\sigma_i^2} \quad \sigma_0 = 6.8\ mm \quad \sigma_i = 6.8\ mm$$

$$P = N = Q_x$$

$$Q_x = \begin{vmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{vmatrix}$$

•Postavljanje hipoteza

$$H_0: Tačke\ pripadaju\ istoj\ pravoj.$$

$$H_a: Tačke\ ne\ pripadaju\ istoj\ pravoj.$$

$$H_0:\ M\begin{bmatrix} \nu_1^2 - \nu_2^3 \\ \nu_2^3 - \nu_3^4 \\ \nu_3^4 - \nu_4^5 \\ \nu_4^5 - \nu_5^6 \\ \nu_5^6 - \nu_6^7 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \qquad H_a:\ M\begin{bmatrix} \nu_1^2 - \nu_2^3 \\ \nu_2^3 - \nu_3^4 \\ \nu_3^4 - \nu_4^5 \\ \nu_4^5 - \nu_5^6 \\ \nu_5^6 - \nu_6^7 \end{bmatrix} \neq \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

•Funkcije veze

$$L_1\colon\ \nu_1^2 - \nu_2^3 = \tan^{-1}\frac{Y_2 - Y_1}{X_2 - X_1} - \tan^{-1}\frac{Y_3 - Y_2}{X_3 - X_2}$$

$$L_2\colon\ \nu_2^3 - \nu_3^4 = \tan^{-1}\frac{Y_3 - Y_2}{X_3 - X_2} - \tan^{-1}\frac{Y_4 - Y_3}{X_4 - X_3}$$

$$L_3\colon\ \nu_3^4 - \nu_4^5 = \tan^{-1}\frac{Y_4 - Y_3}{X_4 - X_3} - \tan^{-1}\frac{Y_5 - Y_4}{X_5 - X_4}$$

$$L_4\colon\ \nu_4^5 - \nu_5^6 = \tan^{-1}\frac{Y_5 - Y_4}{X_5 - X_4} - \tan^{-1}\frac{Y_6 - Y_5}{X_6 - X_5}$$

$$L_5\colon\ \nu_5^6 - \nu_6^7 = \tan^{-1}\frac{Y_6 - Y_5}{X_6 - X_5} - \tan^{-1}\frac{Y_7 - Y_6}{X_7 - X_6}$$

•Matrica koeficijenata H

$$H = \begin{vmatrix} \frac{\partial L_1}{\partial X_1} & \frac{\partial L_1}{\partial Y_1} & \frac{\partial L_1}{\partial X_2} & \frac{\partial L_1}{\partial Y_2} & \frac{\partial L_1}{\partial X_3} & \frac{\partial L_1}{\partial Y_3} & \frac{\partial L_1}{\partial X_4} & \frac{\partial L_1}{\partial Y_4} & \frac{\partial L_1}{\partial X_5} & \frac{\partial L_1}{\partial Y_5} & \frac{\partial L_1}{\partial X_6} & \frac{\partial L_1}{\partial Y_6} & \frac{\partial L_1}{\partial X_7} & \frac{\partial L_1}{\partial Y_7} \\ \frac{\partial L_2}{\partial X_1} & \frac{\partial L_2}{\partial Y_1} & \frac{\partial L_2}{\partial X_2} & \frac{\partial L_2}{\partial Y_2} & \frac{\partial L_2}{\partial X_3} & \frac{\partial L_2}{\partial Y_3} & \frac{\partial L_2}{\partial X_4} & \frac{\partial L_2}{\partial Y_4} & \frac{\partial L_2}{\partial X_5} & \frac{\partial L_2}{\partial Y_5} & \frac{\partial L_2}{\partial X_6} & \frac{\partial L_2}{\partial Y_6} & \frac{\partial L_2}{\partial X_7} & \frac{\partial L_2}{\partial Y_7} \\ \frac{\partial L_3}{\partial X_1} & \frac{\partial L_3}{\partial Y_1} & \frac{\partial L_3}{\partial X_2} & \frac{\partial L_3}{\partial Y_2} & \frac{\partial L_3}{\partial X_3} & \frac{\partial L_3}{\partial Y_3} & \frac{\partial L_3}{\partial X_4} & \frac{\partial L_3}{\partial Y_4} & \frac{\partial L_3}{\partial X_5} & \frac{\partial L_3}{\partial Y_5} & \frac{\partial L_3}{\partial X_6} & \frac{\partial L_3}{\partial Y_6} & \frac{\partial L_3}{\partial X_7} & \frac{\partial L_3}{\partial Y_7} \\ \frac{\partial L_4}{\partial X_1} & \frac{\partial L_4}{\partial Y_1} & \frac{\partial L_4}{\partial X_2} & \frac{\partial L_4}{\partial Y_2} & \frac{\partial L_4}{\partial X_3} & \frac{\partial L_4}{\partial Y_3} & \frac{\partial L_4}{\partial X_4} & \frac{\partial L_4}{\partial Y_4} & \frac{\partial L_4}{\partial X_5} & \frac{\partial L_4}{\partial Y_5} & \frac{\partial L_4}{\partial X_6} & \frac{\partial L_4}{\partial Y_6} & \frac{\partial L_4}{\partial X_7} & \frac{\partial L_4}{\partial Y_7} \\ \frac{\partial L_5}{\partial X_1} & \frac{\partial L_5}{\partial Y_1} & \frac{\partial L_5}{\partial X_2} & \frac{\partial L_5}{\partial Y_2} & \frac{\partial L_5}{\partial X_3} & \frac{\partial L_5}{\partial Y_3} & \frac{\partial L_5}{\partial X_4} & \frac{\partial L_5}{\partial Y_4} & \frac{\partial L_5}{\partial X_5} & \frac{\partial L_5}{\partial Y_5} & \frac{\partial L_5}{\partial X_6} & \frac{\partial L_5}{\partial Y_6} & \frac{\partial L_5}{\partial X_7} & \frac{\partial L_5}{\partial Y_7} \end{vmatrix}$$

$H =$

X1	Y1	X2	Y2	X3	Y3	X4	Y4	X5	Y5	X6	Y6	X7	Y7
20,6265	-0,0206	-41,253	0,0619	20,6264	-0,0413	0	0	0	0	0	0	0	0
0	0	20,6264	-0,041	-41,253	0,0825	20,6264	-0,0413	0	0	0	0	0	0
0	0	0	0	20,6264	-0,0413	-41,253	0,0619	20,6265	-0,0206	0	0	0	0
0	0	0	0	0	0	20,6265	-0,0206	-41,253	0,0413	20,6265	-0,0206	0	0
0	0	0	0	0	0	0	0	20,6265	-0,0206	-41,252	-0,1031	20,6258	0,1238

•Vektor odstupanja d

$$d = \begin{bmatrix} \nu_1^2 - \nu_2^3 \\ \nu_2^3 - \nu_3^4 \\ \nu_3^4 - \nu_4^5 \\ \nu_4^5 - \nu_5^6 \\ \nu_5^6 - \nu_6^7 \end{bmatrix} \qquad d = \begin{vmatrix} 206{,}26432 \\ -1{,}023\text{E-}10 \\ -206{,}26432 \\ 0 \\ -1443{,}8387 \end{vmatrix}$$

•Matrica Q_d $\quad Q_d = HQ_xH^T$

$$Q_d = \begin{vmatrix} 2552{,}71 & -1701{,}8 & 425{,}451 & 0 & 0 \\ -1701{,}8 & 2552{,}7 & -1701{,}8 & 425{,}45 & 0 \\ 425{,}451 & -1701{,}8 & 2552{,}71 & -1702 & 425{,}452 \\ 0 & 425{,}45 & -1701{,}8 & 2552{,}7 & -1701{,}8 \\ 0 & 0 & 425{,}452 & -1702 & 2552{,}65 \end{vmatrix}$$

•Matrica Q_d^{-1}

$$Q_d^{-1} = \begin{vmatrix} 0{,}0013 & 0{,}00168 & 0{,}0015 & 0{,}00101 & 0{,}0004 \\ 0{,}0017 & 0{,}00336 & 0{,}0034 & 0{,}00235 & 0{,}001 \\ 0{,}0015 & 0{,}00336 & 0{,}0044 & 0{,}00336 & 0{,}0015 \\ 0{,}001 & 0{,}00235 & 0{,}0034 & 0{,}00336 & 0{,}0017 \\ 0{,}0004 & 0{,}00101 & 0{,}0015 & 0{,}00168 & 0{,}0013 \end{vmatrix}$$

•Test statistika

$$T = \frac{d^T Q_d^{-1} d}{k\sigma_0^2} \approx F_{0.95}(k, \infty)$$

$$k - rang\ matrice\ H\ , \qquad F_{0.95}(k, \infty) - kvantil\ Fišerovog\ rasporeda$$

$$k = rang(H) = 5$$

$$T = 14.6441 \quad > \quad F_{0.95}(5, \infty) = 2.2150$$

ZAKLJUČAK:

Nulta hipoteza H_0 se odbacuje. Prihvata se alternativna hipoteza H_a: tačke ne pripadaju istoj pravoj.

ZADATAK 5

$\alpha = X \qquad \alpha_0 = X_0 \qquad \gamma_0 = 180 - (X_0 + Y_0)$

$\beta = Y \qquad \beta_0 = Y_0$

•Jednačine popravaka

$$\alpha + v_\alpha = \alpha \qquad v_\alpha = X - \alpha \qquad f_\alpha = 0$$

$$\beta + v_\beta = \beta \qquad v_\beta = Y - \beta \qquad f_\beta = 0$$

$$\gamma + v_\gamma = 180^\circ - (X + Y) \qquad v_\gamma = 180^\circ - (X + Y) \qquad f_\gamma = -12''$$

•Matrica dizajna A i matrica težina P

$$A = \begin{vmatrix} 1 & 0 \\ 0 & 1 \\ -1 & -1 \end{vmatrix} \qquad P = \begin{vmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{vmatrix}$$

•Vektor slobodnih članova f

$$f = \begin{vmatrix} 0 \\ 0 \\ -12 \end{vmatrix}$$

•Matrica koeficijenata normalnih jednacina N i vektor slobodnih članova normalnih jednačina n

$$N = A^T \cdot P \cdot A \qquad n = A^T \cdot P \cdot f$$

$$N = \begin{vmatrix} 2 & 1 \\ 1 & 2 \end{vmatrix} \qquad n = \begin{vmatrix} 12 \\ 12 \end{vmatrix}$$

•Vektor nepoznatih parametara $\hat{x}$ i matrica kofaktora $Q_{\hat{x}}$

$$\hat{x} = -N^{-1} \cdot n = -Q_{\hat{x}} \cdot n$$

$$Q_x = \begin{vmatrix} 0{,}666667 & -0{,}333333 \\ -0{,}33333 & 0{,}6666667 \end{vmatrix} \qquad \hat{x} = \begin{vmatrix} -4 \\ -4 \end{vmatrix}$$

•Vektor popravaka merenih veličina $\hat{V}$

$$\hat{V} = A \cdot \hat{x} + f$$

$$V = \begin{vmatrix} -4 \\ -4 \\ -4 \end{vmatrix}$$

•Kontrola izravnanja

$$\hat{V}^T \cdot P \cdot V = 48 \qquad f^T \cdot P \cdot f + n^T \cdot \hat{x} = 48$$

•Aposteriori standardna devijacija

$$m_0 = \sqrt{\frac{\hat{V}^T \cdot P \cdot V}{f}} \quad , f = n - u \qquad m_0 = \sqrt{\frac{48}{3-2}} = 6.928203$$

•Globalni test na grube greške

-Hipoteze

$$H_0: \sigma^2 = \sigma_0^2 \quad , \quad H_a: \sigma^2 \neq \sigma_0^2 \quad , \quad \sigma = m_0$$

-Test statistika

$$F = \frac{m_0^2}{\sigma_0^2} = 1.58678 \; > \; F(0.05,1,\infty) = 3.84146$$

=> Prihavata se H_0

Nema grubih grešaka!!

•Izravnate vrednosti

$$\hat{\alpha} = 32^\circ\, 45'\, 38''$$

$$\hat{\beta} = 90^\circ\, 00'\, 08''$$

$$\hat{\gamma} = 57^\circ\, 14'\, 14''$$

•Postavljanje hipoteza

$$H_0: Trougao\ je\ pravougli$$

$$H_a: Trougao\ nije\ pravougli$$

$$H_0:\ M[\beta - 90°] = 0 \qquad H_a:\ M[\beta - 90°] \neq 0$$

•Matrica koeficijenata H

$$H = \begin{vmatrix} 0 & 1 \end{vmatrix}$$

•Vektor odstupanja d

$$d = \begin{vmatrix} 8 \end{vmatrix}$$

•Matrica Q_d $\quad Q_d = HQ_xH^T$

$$Q_d = \begin{vmatrix} 0{,}666667 \end{vmatrix}$$

•Matrica Q_d^{-1}

$$Q_d^{-1} = \begin{vmatrix} 1{,}5 \end{vmatrix}$$

•Test statistika

$$T = \frac{d^T Q_d^{-1} d}{k\sigma_0^2} \approx F_{0.95}(k, \infty)$$

$$k - rang\ matrice\ H\ , \qquad F_{0.95}(k, \infty) - kvantil\ Fišerovog\ rasporeda$$

$$k = rang(H) = 1$$

$$T = 3.173354 \quad > \quad F_{0.95}(1, \infty) = 3.841552$$

ZAKLJUČAK:

Alternativna hipoteza H_a se odbacuje. Prihvata se nulta hipoteza H_0: trougao je pravougli.