Ferris State University

Surveying Engineering

Surveying Computation - SURE 215

PROBLEM NUMBER 100

Polaris Observation Reduction For Azimuth

Designed by: S.R. Hashimi

Write your answers in the spaces provided

From The Following Observation Compute:

A. The Azimuth Of The Line For Each Set

B. The Mean Of All The Sets And Its Standard Deviation

Station Occupied Name = "D"

Back Sight Station Name = "E"

Date of Observation (MM:DD:YYYY) = 11/22/2003

Latitude of Station (DD MM SS.ss)= 43 41 20.0

Longitude of Station (DD MM SS.ss)= -85 29 41.0

Standard Longitude of Station (HH MM SS.ss) = -5 0 0

Set Number	B.S. Dir. DDD MM SS	Star Dir. DDD MM SS	Time Dir. HH MM SS	B.S. Rev. DDD MM SS	Star Rev. DDD MM SS	Time Rev. HH MM SS
1	0 2 15	327 26 32	21 8 23	180 2 13	147 25 55	21 11 4
2	45 8 34	12 30 49	21 16 45	225 8 37	192 30 13	21 19 33
3	90 30 4	57 50 15	21 25 44	270 30 7	237 49 35	21 28 55
4	135 20 58	102 39 43	21 35 6	315 20 55	282 38 44	21 38 30

Set No.	Az. Line Dir.	Az. Line Rev.
1	_____	_____
2	_____	_____
3	_____	_____
4	_____	_____

Mean Az. of Line = _____

November 2003

2003 Date	SUN Declination	----- For 0 hrs Universal Time --- GHA	Eq o Time	Semi-Di	---- Polaris Declination	--- 0 hrs UT GHA	
	d m s	d m s	m s	m s	d m s	d m s	h
Nov 1 SA	-14 13 25.6	184 05 39.7	+16 22.65	16 06.7	89 16 50.9	0 34 09.4	23
Nov 2 SU	-14 32 40.7	184 06 06.7	+16 24.45	16 07.0	89 16 51.3	1 33 15.4	23
Nov 3 MO	-14 51 41.6	184 06 21.9	+16 25.46	16 07.2	89 16 51.7	2 32 22.8	23
Nov 4 TU	-15 10 27.9	184 06 25.2	+16 25.68	16 07.5	89 16 52.1	3 31 30.8	23
Nov 5 WE	-15 28 59.2	184 06 16.5	+16 25.10	16 07.7	89 16 52.5	4 30 38.8	23
Nov 6 TH	-15 47 15.1	184 05 55.6	+16 23.70	16 08.0	89 16 52.8	5 29 46.1	23
Nov 7 FR	-16 05 15.3	184 05 22.3	+16 21.49	16 08.2	89 16 53.1	6 28 52.4	23
Nov 8 SA	-16 22 59.4	184 04 36.6	+16 18.44	16 08.5	89 16 53.5	7 27 57.8	23
Nov 9 SU	-16 40 26.9	184 03 38.4	+16 14.56	16 08.7	89 16 53.8	8 27 02.3	23
Nov 10 MO	-16 57 37.6	184 02 27.5	+16 09.83	16 08.9	89 16 54.2	9 26 06.3	23
Nov 11 TU	-17 14 31.0	184 01 03.8	+16 04.25	16 09.2	89 16 54.5	10 25 10.3	23
Nov 12 WE	-17 31 06.7	183 59 27.3	+15 57.82	16 09.4	89 16 54.9	11 24 14.7	23
Nov 13 TH	-17 47 24.5	183 57 38.0	+15 50.53	16 09.6	89 16 55.3	12 23 20.3	23
Nov 14 FR	-18 03 23.8	183 55 35.8	+15 42.38	16 09.8	89 16 55.7	13 22 27.3	23
Nov 15 SA	-18 19 04.3	183 53 20.6	+15 33.37	16 10.0	89 16 56.1	14 21 36.1	22
Nov 16 SU	-18 34 25.7	183 50 52.5	+15 23.50	16 10.2	89 16 56.5	15 20 46.8	22
Nov 17 MO	-18 49 27.5	183 48 11.5	+15 12.76	16 10.5	89 16 56.9	16 19 59.4	22
Nov 18 TU	-19 04 09.3	183 45 17.6	+15 01.17	16 10.7	89 16 57.3	17 19 13.3	22
Nov 19 WE	-19 18 30.7	183 42 10.9	+14 48.73	16 10.9	89 16 57.7	18 18 27.9	22
Nov 20 TH	-19 32 31.5	183 38 51.6	+14 35.44	16 11.1	89 16 58.1	19 17 42.3	22
Nov 21 FR	-19 46 11.1	183 35 19.7	+14 21.31	16 11.3	89 16 58.4	20 16 55.5	22
Nov 22 SA	-19 59 29.2	183 31 35.4	+14 06.36	16 11.5	89 16 58.7	21 16 06.8	22
Nov 23 SU	-20 12 25.4	183 27 38.9	+13 50.59	16 11.6	89 16 59.0	22 15 16.2	22
Nov 24 MO	-20 24 59.3	183 23 30.4	+13 34.03	16 11.8	89 16 59.4	23 14 24.2	22
Nov 25 TU	-20 37 10.7	183 19 10.3	+13 16.69	16 12.0	89 16 59.7	24 13 32.3	22
Nov 26 WE	-20 48 59.0	183 14 38.8	+12 58.59	16 12.2	89 17 00.1	25 12 41.9	22
Nov 27 TH	-21 00 24.1	183 09 56.3	+12 39.75	16 12.4	89 17 00.6	26 11 54.0	22
Nov 28 FR	-21 11 25.4	183 05 02.9	+12 20.20	16 12.6	89 17 01.0	27 11 09.1	22
Nov 29 SA	-21 22 02.7	182 59 59.1	+11 59.94	16 12.7	89 17 01.4	28 10 26.8	22
Nov 30 SU	-21 32 15.7	182 54 45.2	+11 39.01	16 12.9	89 17 01.8	29 09 46.2	21

to December

POLARIS OBSERVATION REDUCTIONS

		Set 1	Set 2	Comments/ Operations	
1	Backsight D	0° 02' 15"	45° 08' 34"		
2	F	180° 02' 13"	225° 08' 37"		
3	Average	0° 02' 14"	45° 08' 35.5"		
4	Foresight D	327° 26' 32"	12° 30' 49"		
5	F	147° 25' 55"	192° 30' 13"		
6	Average	327° 26' 13.5"	12° 30' 31"		
7	Angle: FS – BS	327° 23' 59.5"	327° 21' 55.5"	6-3	
8	Time D	21h 09m 23s	21h 16m 45s		
9	R	21h 11m 04s	21h 19m 33s		
10	Average	21h 09m 43.5s	21h 18m 09s		
11	Zone Correction	5h	5h		
12	Greenwich Civil Time of Observation	26h 09m 43.5s	26h 19m 09s	GCT 10+11	11/22/03
13		2h 09m 43.5s	2h 18m 09s	GCT	11/23/03
14	Greenwich Hour Angle @ 0h UT	22° 15' 16.2"	22° 15' 16.2"	GHA	
15	Change in Sidereal Time *	32° 31' 12.2"	34° 37' 55.4"		
16	GHA @ Time of Observation	54° 46' 28.4"	56° 53' 11.6"		
17	Longitude (West -, East +)	-85° 29' 41.0"	-85° 29' 41.0"		
18	Local Hour Angle Polaris	329° 16' 47.4"	331° 23' 30.6"	16+17	
19	Hour Angle **	30° 43' 12.6"	28° 36' 29.4"	t	
20	Declination (δ)	89° 16' 59"	89° 16' 59"		
21	Latitude (φ)	43° 41' 20"	43° 41' 20"		
22	Azimuth of Polaris ***	0° 30' 42.4"	0° 28' 47.2"	Z	
23	Azimuth of Line	33° 06' 42.9"	33° 06' 51.7"		
24	Mean Azimuth of All Sets	33° 06' 37.8"			

Note that operations in red refer to the line number in the table.

* Compute the Change in Sidereal Time using:

$$\text{Change} = \text{GCT} * \left(15^{\circ}/_{\text{h}}\right) * \left(\frac{366.2422}{365.2422}\right)$$

** If the LHA > 180°, then t = 360° – LHA and t is east and +.
If the LHA < 180°, then t = LHA and t is west and -.

** *The Azimuth is computed as:

$$\tan Z = \frac{\sin t}{\tan\delta\cos\varphi - \sin\varphi\cos t}$$

POLARIS OBSERVATION REDUCTIONS

		Set 3	Set 4	Comments/ Operations	
1	Backsight D	90° 30' 04"	135° 20' 58"		
2	F	270° 30' 07"	315° 20' 55"		
3	Average	90° 30' 05.5"	135° 20' 56.5"		
4	Foresight D	57° 50' 15"	102° 39' 43"		
5	F	237° 49' 35"	282° 38' 44"		
6	Average	57° 49' 55"	102° 39' 13.5"		
7	Angle: FS – BS	327° 19' 49.5"	327° 18' 17"	6-3	
8	Time D	$21^h\ 25^m\ 44^s$	$21^h\ 35^m\ 06^s$		
9	R	$21^h\ 28^m\ 55^s$	$21^h\ 38^m\ 30^s$		
10	Average	$21^h\ 27^m\ 19.5^s$	$21^h\ 36^m\ 48^s$		
11	Zone Correction	5^h	5^h		
12	Greenwich Civil Time of Observation	$26^h\ 27^m\ 19.5^s$	$26^h\ 36^m\ 48^s$	GCT 10+11	11/22/03
13		$2^h\ 27^m\ 19.5^s$	$2^h\ 36^m\ 48^s$	GCT	11/23/03
14	Greenwich Hour Angle @ 0^h UT	22° 15' 16.2"	22° 15' 16.2"	GHA	
15	Change in Sidereal Time *	36° 55' 55.5"	39° 18' 26.4"		
16	GHA @ Time of Observation	59° 11' 11.7"	61° 33' 42.6"		
17	Longitude (West -, East +)	-85° 29' 41"	-85° 29' 41"		
18	Local Hour Angle Polaris	333° 41' 30.7"	336° 04' 01.6"	16+17	
19	Hour Angle **	26° 18' 29.3"	23° 55' 58.4"	t	
20	Declination (δ)	89° 16' 59"	89° 16' 59"		
21	Latitude (φ)	43° 41' 20"	43° 41' 20"		
22	Azimuth of Polaris ***	0° 26' 39.1"	0° 24' 24.0"	Z	
23	Azimuth of Line	33° 06' 49.6"	33° 06' 07.0"		
24	Mean Azimuth of All Sets				

Note that operations in red refer to the line number in the table.

* Compute the Change in Sidereal Time using:

$$\text{Change} = \text{GCT} * \left(15^\circ/_h\right) * \left(\frac{366.2422}{365.2422}\right)$$

** If the LHA > 180°, then t = 360° – LHA and t is east and +.
If the LHA < 180°, then t = LHA and t is west and -.

** *The Azimuth is computed as:

$$\tan Z = \frac{\sin t}{\tan\delta\cos\varphi - \sin\varphi\cos t}$$

	Set 1			Set 2		
BS - Direct	0	2	15	45	8	34
BS - Reverse	180	2	13	225	8	37
	0.0375	180.0369	0.037222	45.14278	225.1436	45.14319
FS - Direct	327	26	32	12	30	49
FS - Reverse	147	25	55	192	30	13
	327.4422	147.4319	327.4371	12.51361	192.5036	12.50861
	327.3999			327.3654		
Angle	327	23	59.5	327	21	55.5
Time - Direct	21	8	23	21	16	45
Time - Reverse	21	11	4	21	19	33
	21.13972	21.18444	21.16208	21.27917	21.32583	21.3025
Time	21	9	43.5	21	18	9
Zone Corr	5			5		
GCT of Obs	2.162083			2.3025		
GHA @ 0hr UT	22	15	16.2	22	15	16.2
Change in Sidereal Time	32.52005			34.63207		
GHA Polaris @ Obs. Time	54.77455	54.77455		56.88657	56.88657	
Longitude	-85	29	41	-85	29	41
	-85.4947			-85.4947		
LHA Polaris	-30.7202			-28.6082		
t	30.72017			28.60816		
Declination	89	16	59	89	16	59
Latitude	43	41	20	43	41	20
t, decl, lat - radians	0.536168	1.558283	0.762515	0.499307	1.558283	0.762515
tan Z - Z (dec degrees)	0.008932		0.511768	0.008374		0.479789
Z	0	30	42.36555	0	28	47.23977
	-326.888	33.11191		-326.886	33.11437	
Azimuth	33	6	42.86555	33	6	51.73977
	33.1105					

Average Azimuth	33	6	37.80817
Standard Deviation			18.07977

	Set 3			Set 4		
BS - Direct	90	30	4	135	20	58
BS - Reverse	270	30	7	315	20	55
	90.50111	270.5019	90.50153	135.3494	315.3486	135.349
FS - Direct	57	50	15	102	39	43
FS - Reverse	237	49	35	282	38	44
	57.8375	237.8264	57.83194	102.6619	282.6456	102.6538
	327.3304			327.3047		
Angle	327	19	49.5	327	18	17
Time - Direct	21	25	44	21	35	6
Time - Reverse	21	28	55	21	38	30
	21.42889	21.48194	21.45542	21.585	21.64167	21.61333
Time	21	27	19.5	21	36	48
Zone Corr	5			5		
GCT of Obs	2.455417			2.613333		
GHA @ 0hr UT	22	15	16.2	22	15	16.2
Change in Sidereal Time	36.9321			39.30733		
GHA Polaris @ Obs. Time	59.1866	59.1866		61.56183	61.56183	
Longitude	-85	29	41	-85	29	41
	-85.4947			-85.4947		
LHA Polaris	-26.3081			-23.9329		
t	26.30813			23.93289		
Declination	89	16	59	89	16	59
Latitude	43	41	20	43	41	20
t, decl, lat - radians	0.459163	1.558283	0.762515	0.417708	1.558283	0.762515
tan Z - Z (dec degrees)	0.007753		0.444199	0.007098		0.40667
Z	0	26	39.11574	0	24	24.01162
	-326.886	33.11378		-326.898	33.10195	
Azimuth	33	6	49.61574	33	6	7.011619