Faculty of Engineering

Prince of Songkla University

Final Examination — 1st Semester 2010

October 11th, 2010 — Room **A401**

221 – 361 **Surveying II** — Time: 9:00 - 12:00 (3 hours)

Instructions

1. There are 5 problems in this exam. (100 points)
2. Attempt all problems.
3. Books and lecture notes are not allowed.
4. Students can bring in a calculator and a dictionary.
5. Students can use pencil in the answer books.

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1) a) Explain the effects of parallax and refraction on astronomical observation. Also sketch the diagram that clearly shows the relations among parallax, refraction and altitude of a celestial body. (10 points)

b) Explain the reasons why one shouldn't take the solar observation at noon. What is the suitable time interval of the day for determining the astronomical azimuth of a line by solar observation? (10 points)

2) On October 11th, the surveyor measures the altitude of the sun from station A by using Leica Total Station. The latitude of station A is known to be 37° 52′ 20″ N and the longitude of A is 120° W. The temperature during the observation is 75°F and the barometric pressure of the day is recorded as 29.3″ Hg. The field-book record of his field data is shown in the table below which also include the horizontal angle to the station B. Determine the azimuth of the sun as well as the azimuth to the reference line AB. (25 points)

Sta	To	Face	Hor. Cir. Rdg.	Ver. Cir. Rdg.	Time (Local)	Remarks
A	**B**	D	345° 15′ 28″			Chatchai
	Sun	D	048° 17′ 15″	058° 38′ 20″	$14^h\ 40^m\ 30^s$	
	Sun	R	228° 16′ 10″	301° 19′ 30″	$14^h\ 42^m\ 40^s$	
	B	R	168° 14′ 03″			

Hint: GMT = Local time + 8^h

3) Prepare the table required for staking out at every 25 m. full station of a horizontal curve by deflection angle method. Given the radius of the curve R = 180.000 m., the deflection angle θ = 80° 00′ 00″ and the stationing at PI = 18+053.892 km. Also calculate the stationings of PC and PT. (15 points)

4) An entering grade of – 2% meets a departing grade of +1.5% at station 8+735.00 km. The two grades intersect at an elevation of 400.00 m. above mean sea level. If these two grades are connected by a 200-m equal-tangent curve, computing the elevation of points BVC, EVC and all full stations POC for every 25m. Also determine the location and elevation of the lowest point on the curve. (20 points)

5) Given A and B are two control points whose coordinates are X_A = 25,068.670 m. Y_A = 29,693.183 m. and X_B = 26,984.819 m. Y_B = 24,424.234 m. respectively. The engineer has chosen station B as the entrance of the proposed new tunnel that shall be drilled through the mountain range DE as shown in the sketched diagram. The station C is planned to be the location of the exit point of the tunnel. Stations B and C are invisible from each others because of the mountain range DE. A Leica Total station was set up at station A and the following measurements were recorded and shown in the table below. Please determine the azimuth of the axis of the tunnel BC. (20 points)

Station	To	Face	Hor. Cir. Rdg.	Ver. Cir. Rdg.	Slope Distance	Remarks
A	**B**	**L**	225° 12′ 15″			
	C	**L**	257 40 30	088° 45′ 50″	9,849.406	
	C	**R**	077 40 36	271 14 20	9,849.408	
	B	**R**	045 12 11			

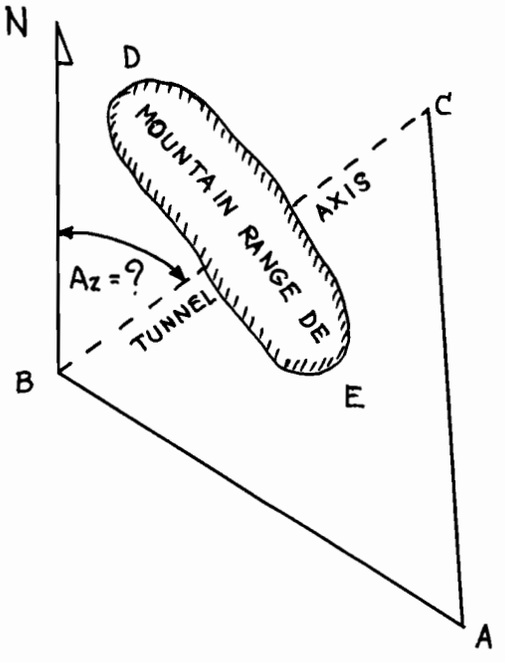

TABLE 1

SOLAR EPHEMERIS **OCTOBER** 1984

For 0^h Universal Time or Greenwich Civil Time

Day of Month & Week		The Sun's Apparent Declination	Diff. in Declin. for 1 hour	Equation of Time: True Sol. Time = LCT + Eq. of Time	Differ for 1 hour	GHA of Polaris
		° ′	′	m s	s	° ′
1	M	S03 10.3	0.97	+10 16.3	0.80	335 41.2
2	TU	S03 33.5	0.97	+10 35.5	0.79	336 40.1
3	W	S03 56.7	0.97	+10 54.4	0.78	337 39.1
4	TH	S04 19.9	0.96	+11 13.0	0.76	338 38.0
5	FR	S04 43.0	0.96	+11 31.3	0.75	339 37.0
6	SA	S05 06.1	0.96	+11 49.2	0.73	340 36.0
7	SU	S05 29.1	0.96	+12 06.7	0.71	341 35.0
8	M	S05 52.0	0.95	+12 23.9	0.70	342 34.0
9	TU	S06 14.9	0.95	+12 40.6	0.68	343 33.0
10	W	S06 37.6	0.94	+12 56.9	0.66	344 32.0
11	TH	S07 00.3	0.94	+13 12.7	0.64	345 31.0
12	FR	S07 22.9	0.94	+13 28.0	0.62	346 29.9
13	SA	S07 45.4	0.93	+13 42.8	0.59	347 28.9
14	SU	S08 07.8	0.93	+13 57.1	0.57	348 27.8
15	M	S08 30.0	0.92	+14 10.8	0.55	349 26.8
16	TU	S08 52.2	0.92	+14 24.0	0.52	350 25.7
17	W	S09 14.2	0.91	+14 36.5	0.50	351 24.7
18	TH	S09 36.1	0.91	+14 48.5	0.47	352 23.7
19	FR	S09 57.8	0.90	+14 59.8	0.45	353 22.7
20	SA	S10 19.4	0.89	+15 10.5	0.42	354 21.8
21	SU	S10 40.9	0.89	+15 20.5	0.39	355 20.9
22	M	S11 02.2	0.88	+15 29.8	0.36	356 20.0
23	TU	S11 23.4	0.87	+15 38.5	0.33	357 19.1
24	W	S11 44.3	0.87	+15 46.5	0.30	358 18.1
25	TH	S12 05.1	0.86	+15 53.7	0.27	359 17.2
26	FR	S12 25.7	0.85	+16 00.2	0.24	000 16.2
27	SA	S12 46.1	0.84	+16 06.1	0.21	001 15.2
28	SU	S13 06.4	0.83	+16 11.1	0.18	002 14.2
29	M	S13 26.4	0.82	+16 15.5	0.15	003 13.2
30	TU	S13 46.2	0.82	+16 19.1	0.12	004 12.3
31	W	S14 05.8	0.81	+16 21.9	0.09	005 11.4
32	TH	S14 25.1		+16 23.9		006 10.5

Hourly differences in declination and equation of time are for the 24-hours following 0-hours of date in left column.

TABLE 1

SOLAR EPHEMERIS **NOVEMBER** 1984

For 0^h Universal Time or Greenwich Civil Time

Day of Month & Week		The Sun's Apparent Declination	Diff. in Declin. for 1 hour	Equation of Time: True Sol. Time = LCT + Eq. of Time	Differ. for 1 hour	GHA of Polaris
		° ′	′	m s	s	° ′
1	TH	S14 25.1	0.80	+16 23.9	0.05	006 10.5
2	FR	S14 44.2	0.79	+16 25.2	0.02	007 09.7
3	SA	S15 03.1	0.78	+16 25.7	0.01	008 08.9
4	SU	S15 21.7	0.77	+16 25.4	0.05	009 08.0
5	M	S15 40.1	0.75	+16 24.3	0.08	010 07.2
6	TU	S15 58.2	0.74	+16 22.3	0.12	011 06.3
7	W	S16 16.1	0.73	+16 19.5	0.15	012 05.5
8	TH	S16 33.6	0.72	+16 15.9	0.19	013 04.6
9	FR	S16 50.9	0.71	+16 11.5	0.22	014 03.7
10	SA	S17 07.9	0.70	+16 06.2	0.26	015 02.9
11	SU	S17 24.7	0.68	+16 00.1	0.29	016 02.0
12	M	S17 41.1	0.67	+15 53.1	0.33	017 01.1
13	TU	S17 57.2	0.66	+15 45.2	0.36	018 00.2
14	W	S18 13.0	0.65	+15 36.5	0.40	018 59.4
15	TH	S18 28.5	0.63	+15 26.9	0.44	019 58.6
16	FR	S18 43.7	0.62	+15 16.4	0.47	020 57.9
17	SA	S18 58.5	0.60	+15 05.1	0.51	021 57.1
18	SU	S19 13.0	0.59	+14 52.9	0.54	022 56.4
19	M	S19 27.1	0.58	+14 39.9	0.58	023 55.7
20	TU	S19 40.9	0.56	+14 26.1	0.61	024 54.9
21	W	S19 54.4	0.55	+14 11.4	0.65	025 54.1
22	TH	S20 07.5	0.53	+13 55.9	0.68	026 53.3
23	FR	S20 20.2	0.51	+13 39.6	0.71	027 52.5
24	SA	S20 32.5	0.50	+13 22.5	0.74	028 51.7
25	SU	S20 44.5	0.48	+13 04.6	0.78	029 50.9
26	M	S20 56.1	0.47	+12 46.0	0.81	030 50.1
27	TU	S21 07.3	0.45	+12 26.7	0.83	031 49.4
28	W	S21 18.0	0.43	+12 06.6	0.86	032 48.7
29	TH	S21 28.4	0.42	+11 45.9	0.89	033 48.0
30	FR	S21 38.4	0.40	+11 24.5	0.92	034 47.4
31	SA	S21 47.9		+11 02.5		035 46.7

Hourly differences in declination and equation of time are for the 24-hours following 0-hours of date in left column.

TABLE 1

SOLAR EPHEMERIS **DECEMBER** 1984

For 0^h Universal Time or Greenwich Civil Time

Day of Month & Week		The Sun's Apparent Declination	Diff. in Declin. for 1 hour	Equation of Time: True Sol. Time = LCT + Eq. of Time	Differ. for 1 hour	GHA of Polaris
		° ′	′	m s	s	° ′
1	SA	S21 47.9	0.38	+11 02.5	0.94	035 46.7
2	SU	S21 57.1	0.36	+10 39.8	0.97	036 46.1
3	M	S22 05.8	0.35	+10 16.5	0.99	037 45.4
4	TU	S22 14.1	0.33	+09 52.7	1.02	038 44.7
5	W	S22 21.9	0.31	+09 28.2	1.04	039 44.1
6	TH	S22 29.4	0.29	+09 03.3	1.06	040 43.4
7	FR	S22 36.4	0.27	+08 37.8	1.08	041 42.7
8	SA	S22 42.9	0.25	+08 11.8	1.10	042 41.9
9	SU	S22 49.0	0.24	+07 45.3	1.12	043 41.2
10	M	S22 54.6	0.22	+07 18.4	1.14	044 40.6
11	TU	S22 59.8	0.20	+06 51.1	1.15	045 39.9
12	W	S23 04.6	0.18	+06 23.4	1.17	046 39.3
13	TH	S23 08.9	0.16	+05 55.3	1.18	047 38.7
14	FR	S23 12.7	0.14	+05 26.9	1.20	048 38.1
15	SA	S23 16.1	0.12	+04 58.1	1.21	049 37.6
16	SU	S23 19.0	0.10	+04 29.1	1.22	050 37.0
17	M	S23 21.4	0.08	+03 59.8	1.23	051 36.4
18	TU	S23 23.4	0.06	+03 30.3	1.24	052 35.8
19	W	S23 24.9	0.04	+03 00.7	1.24	053 35.2
20	TH	S23 25.9	0.02	+02 30.8	1.25	054 34.5
21	FR	S23 26.4	0.00	+02 00.9	1.25	055 33.9
22	SA	S23 26.5	0.02	+01 30.9	1.25	056 33.3
23	SU	S23 26.2	0.04	+01 00.9	1.25	057 32.6
24	M	S23 25.3	0.06	+00 30.9	1.25	058 32.1
25	TU	S23 24.0	0.07	+00 01.0	1.24	059 31.5
26	W	S23 22.2	0.09	−00 28.9	1.24	060 31.0
27	TH	S23 19.9	0.11	−00 58.6	1.23	061 30.5
28	FR	S23 17.2	0.13	−01 28.2	1.22	062 30.0
29	SA	S23 14.0	0.15	−01 57.5	1.21	063 29.5
30	SU	S23 10.3	0.17	−02 26.7	1.20	064 29.0
31	M	S23 06.2	0.19	−02 55.6	1.19	065 28.5
32	TU	S23 01.6		−03 24.1		066 27.9

Hourly differences in declination and equation of time are for the 24-hours following 0-hours of date in left column.

TABLE 2

REFRACTION AND SUN'S PARALLAX

(To be applied to observed altitudes. See page 16)

Bar. = 29.6 in. Temp. = 50° F.

Measured Altitude	Refraction	Sun's Par.	Measured Altitude	Refraction	Sun's Par.
° ′	′	′	° ′	′	′
7 30	6.88	0.15	17 30	3.02	0.14
7 40	6.75	0.15	18 00	2.93	0.14
7 50	6.62	0.15	18 30	2.85	0.14
8 00	6.50	0.15	19 00	2.77	0.14
8 10	6.37	0.15	19 30	2.70	0.14
8 20	6.25	0.15	20 00	2.62	0.14
8 30	6.13	0.15	21 00	2.48	0.14
8 40	6.02	0.15	22 00	2.36	0.14
8 50	5.92	0.15	23 00	2.25	0.14
9 00	5.82	0.15	24 00	2.15	0.14
9 10	5.72	0.15	25 00	2.05	0.14
9 20	5.63	0.15	26 00	1.96	0.13
9 30	5.53	0.15	27 00	1.88	0.13
9 40	5.43	0.15	28 00	1.80	0.13
9 50	5.34	0.15	29 00	1.73	0.13
10 00	5.26	0.15	30 00	1.66	0.13
10 20	5.10	0.15	32 00	1.53	0.13
10 40	4.95	0.14	34 00	1.42	0.12
11 00	4.81	0.14	36 00	1.32	0.12
11 20	4.67	0.14	38 00	1.23	0.12
11 40	4.54	0.14	40 00	1.15	0.11
12 00	4.42	0.14	42 00	1.07	0.11
12 30	4.25	0.14	44 00	1.00	0.11
13 00	4.09	0.14	46 00	0.93	0.10
13 30	3.93	0.14	48 00	0.86	0.10
14 00	3.78	0.14	50 00	0.80	0.09
14 30	3.65	0.14	55 00	0.67	0.08
15 00	3.53	0.14	60 00	0.55	0.07
15 30	3.42	0.14	65 00	0.45	0.06
16 00	3.32	0.14	70 00	0.35	0.05
16 30	3.22	0.14	80 00	0.17	0.03
17 00	3.12	0.14	90 00	0.00	0.00

The refraction values in Table 2 are corrected by multiplying them by the multipliers in Table 2a when the barometric pressure and the temperature differ from those on which Table 2 is based, i. e. 29.6 inches and 50° F.

If the barometric pressure is not known, it may be estimated from the elevation of the locality in accordance with the values given in Table 2a. Otherwise the elevations are disregarded.

TABLE 2a

To correct Table 2. See Examples below.

MULTIPLIERS FOR OBSERVED BAROMETRIC PRESSURE OR ELEVATION

Bar. (Inches)	Elev. (Feet)	Multiplier	Bar. (Inches)	Elev. (Feet)	Multiplier
30.5	− 451	1.03	23.9	+ 6194	0.81
30.2	− 181	1.02	23.6	6538	0.80
30.0	00	1.01	23.3	6887	0.79
			23.0	7239	0.78
29.9	+ 91	1.01			
29.6	366	1.00	22.7	7597	0.77
29.3	643	0.99	22.4	7960	0.76
29.0	924	0.98	22.1	8327	0.75
28.7	1207	0.97	21.8	8700	0.74
28.4	1493	0.96	21.5	9077	0.73
28.1	1783	0.95	21.2	9460	0.72
27.8	2075	0.94	20.9	9848	0.71
27.5	2371	0.93	20.6	10242	0.70
27.2	2670	0.92	20.3	10642	0.69
			20.0	11047	0.68
26.9	2972	0.91			
26.6	3277	0.90	19.7	11458	0.67
26.3	3586	0.89	19.4	11875	0.66
26.0	3899	0.88	19.1	12299	0.65
25.7	4215	0.87	18.8	12729	0.64
25.4	4535	0.86	18.5	13165	0.63
25.1	4859	0.85	18.2	13608	0.62
24.8	5186	0.84	17.9	14058	0.61
24.5	5518	0.83			
24.2	5854	0.82			

MULTIPLIERS FOR TEMPERATURE

Temp. Deg. F	Multiplier	Temp. Deg. F	Multiplier	Temp. Deg. F	Multiplier
− 20	1.16	+ 30	1.04	+ 80	0.94
− 10	1.13	+ 40	1.02	+ 90	0.93
0	1.11	+ 50	1.00	+100	0.91
+ 10	1.08	+ 60	0.98	+110	0.90
+ 20	1.06	+ 70	0.96	+120	0.88

Example. Sun: Meas. Alt. = 30°; Bar. = 26 in. or Elev. 3900 ft.; Temp. 70° F.
Refraction = 1.66′ (0.88) (0.96) = 1.40′. Parallax = 0.13′.
True Alt. = 30° 00.00′ − 1.40′ + 0.13′ = 29° 58.73′.

Example. Star: Meas. Alt. = 25°; Bar. = 24.5 or Elev. 5518 ft.; Temp. 10° F.
Refraction = 2.05′ (0.83) (1.08) = 1.84′.
True Alt. = 25° 00.00′ − 1.84′ = 24° 58.16′.

TABLE 3

POLAR DISTANCE OF POLARIS 1984

For 0^h Universal Time or Greenwich Civil Time

1984	Polar Distance Angle ° ′	Polar Distance Cotan	1984	Polar Distance Angle ° ′	Polar Distance Cotan
Jan. 1	0 48.24	71.26	July 9	0 48.71	70.57
11	0 48.21	71.30	19	0 48.70	70.59
21	0 48.19	71.33	29	0 48.69	70.60
31	0 48.19	71.33			
Feb. 10	0 48.19	71.33	Aug. 8	0 48.67	70.63
20	0 48.20	71.32	18	0 48.64	70.67
			28	0 48.61	70.72
Mar. 1	0 48.23	71.27	Sep. 7	0 48.56	70.78
11	0 48.26	71.23	17	0 48.52	70.85
21	0 48.30	71.17	27	0 48.46	70.94
31	0 48.35	71.10			
			Oct. 7	0 48.40	71.02
Apr. 10	0 48.40	71.02	17	0 48.34	71.11
20	0 48.45	70.95	27	0 48.28	71.20
30	0 48.50	70.88			
			Nov. 6	0 48.21	71.30
May 10	0 48.54	70.82	16	0 48.15	71.39
20	0 48.59	70.75	26	0 48.09	71.48
30	0 48.63	70.69			
			Dec. 6	0 48.04	71.56
June 9	0 48.66	70.64	16	0 47.98	71.64
19	0 48.68	70.61	26	0 47.94	71.70
29	0 48.70	70.59			

Declination = 90° − Polar Distance

TABLE 4

THE SUN'S SEMI-DIAMETER 1984

For 0^h Universal Time or Greenwich Civil Time

Date	Semi-Diam.	Date	Semi-Diam.	Date	Semi-Diam.
1984	′	1984	′	1984	′
Jan. 1	16.29	May 10	15.86	Sep. 7	15.90
11	16.29	20	15.83	14	15.93
21	16.28	30	15.80	27	15.98
31	16.26				
Feb. 10	16.24	June 9	15.78	Oct. 7	16.03
20	16.20	19	15.76	17	16.08
		29	15.76	27	16.12
Mar. 1	16.17	July 9	15.76	Nov. 6	16.16
11	16.12	19	15.76	16	16.20
21	16.08	29	15.78	26	16.23
31	16.03				
Apr 10	15.99	Aug. 8	15.80	Dec. 6	16.26
20	15.94	18	15.83	16	16.28
30	15.90	28	15.86	26	16.29