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CVG 2171 (Surveying and Measurements)
Mid-Term Exam (March 3rd, 2016)

Duration: 1 hr. 15 min
Closed Book Examination **Professor: A. Skaff**
Non-Programmable electronic calculators are permitted

1. (10 points)

a) Prepare a set of level notes for the data shown below: The elevation of BM 100 is 231.456 m.

b) Determine the error of misclosure and make the usual arithmetic check.

c) Adjust the elevations of BMl01, BMl02 and BMl03 assuming that the error is equally divided among setups.

Station	BS	FS
BM100	1.317	
TP1	1.650	0.814
TP2	1.491	2.050
BM101	1.832	1.286
TP3	1.322	0.839
TP4	0.983	1.324
TP5	0.645	1.635
BM102	1.729	1.493
BM103	1.237	1.116
TP6	1.269	1.588
BM100		1.320

2. (10 points)

A steel tape when standardized at 68ºF and supported throughout its entire length under a tension of 12lb was found to be 100.012 ft. long. The tape has a cross-sectional area of 0.0078 in^2 and weighs 0.0266 lb/ft. In the field this tape was used to measure a line from A to B in six segments. It was held horizontal, supported at the ends and the middle point only each time it was used with a constant tension of 17 lb. These segments were recorded as such: 100.000ft, 100.000ft, 100.000ft, 100.000ft, 100.000ft, and 82.366 ft.

What is the actual distance between A and B after corrections for systematic errors have been applied if the temperature of the tape at the time of measurement was 55ºF?

Coefficient of thermal expansion and contraction of steel is 0.00000 65 /ft/ºF and its modulus of elasticity is 29×10^6 lb/in^2.

3. (10 points)

A total station was set up at control station O, which is within the limits of a five sided property. The coordinates of station O are 2033.000 E (x) and 1990.000 N (y). The azimuths and horizontal distances from O to the five property corners were determined as follow:

Line	**Azimuth**	**Horizontal Distance** (m)
OA	286º 51'00''	34.482
OB	37º 35'28''	31.892
OC	90º 27'56''	38.286
OD	166º 26'49''	30.916
OE	247º 28'43''	32.585

a) Compute the coordinates of the property corners A, B, C, D, and E.
b) Find the length and azimuth of line BC.

Good luck,

USEFUL EQUATIONS

$$C_1 = \frac{(l - l^1)}{l^1} L$$

$$C_t = K(T_1 - T)L$$

$$C_p = (P_1 - P)\frac{L}{AE}$$

$$C_s = -\frac{w^2 L_s^3}{24P_1^2} = -\frac{W^2 L_s}{24P_1^2}$$

$$\text{HI} = Elev. + BS$$

$$Elev. = \text{HI} - FS$$

$$\text{departure} = L \sin \alpha$$

$$\text{latitude} = L \cos \alpha$$

$$\tan \ azimuth \ (or \ bearing) \ AB = \frac{departure \ AB}{latitude \ AB}$$

$$length \ AB = \frac{departure \ AB}{\sin \ azimuth \ (or \ bearing) \ AB}$$

$$= \frac{latitude \ AB}{\cos \ azimuth \ (or \ bearing) \ AB}$$

$$= \sqrt{(departure \ AB)^2 + (latitude \ AB)^2}$$

CVG 2171

SURVEYING & MEASUREMENTS

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SOLUTIONS

Station	BS (m)	H.I.	FS (m)	Elevation (m)	Adjusted Elevation
BM 100	1.317	232.773		231.456	
TP1	1.650	233.609	0.814	231.959	
TP2	1.491	233.050	2.050	231.559	
BM101	1.832	233.596	1.286	231.764	231.761
TP3	1.322	234.079	0.839	232.757	
TP4	0.983	233.738	1.324	232.755	
TP5	0.645	232.748	1.635	232.103	
BM102	1.729	232.984	1.493	231.255	231.248
BM103	1.237	233.105	1.116	231.868	231.860
TP6	1.269	232.786	1.588	231.517	
BM100			1.320	231.466	

b) $\Sigma BS = 13.475$ m.; $\Sigma FS = 13.465$ m.

error of misclosure $= 13.475 - 13.465 =$ **0.01 m.** ANS.

$0.01 + 231.456 = 231.466$ m ✓ check.

c) No of setups $= 10$; ∴ Correction per setup $= \frac{0.01}{10} = 0.001$ m (to be subtracted)

Adjusted elev. of BM 201:

$= 231.764 - (0.001 \times 3) =$ **231.761 m.** ANS.

Adjusted elev. of BM 202:

$231.255 - (0.001 \times 7) =$ **231.248 m.** ANS.

Adjusted elev. of BM 203:

$231.868 - (0.001 \times 8) =$ **231.860 m.** ANS.

2.

Correction for length: $C_l = \left(\frac{l - l'}{l'}\right) L$ $\quad L = 582.366$ ft.

$\therefore C_l = \left(\frac{100.012 - 100.000}{100.000}\right) \times 582.366 =$ **0.070 ft.**

Correction for temperature: $C_t = k(T_1 - T)L$

$\therefore C_t = 0.0000065(55-68) \times 582.366 =$ **-0.049 ft.**

Correction for Pull: $C_p = (P_1 - P)\frac{L}{AE}$

$\therefore C_p = (17-12)\frac{582.366}{0.0078 \times 29 \times 10^6} =$ **0.013 ft.**

Correction for sag: $C_s = -\frac{w^2 L_s^3}{24 P_1^2}$

$C_{s_1} = \frac{(0.0266)^2 \times (50)^3}{24 \times (17)^2} \times 10 = -0.128$ ft.

$C_{s_2} = -\frac{(0.0266)^2 \times \left(\frac{82.366}{2}\right)^2}{24 \times (17)^2} \times 2 = -0.014$ ft.

$\therefore C_s = -0.128 - 0.014 =$ **-0.142 ft**

Hence, actual distance between A & B:

$AB = 582.366 + 0.070 - 0.049 + 0.013 - 0.142 =$ **582.258 ft.**

ANS.

3. a)

x of A $= 2033.000 + 34.482 \sin 286°51'00'' = 2000.000$ m

y of A $= 1990.000 + 34.482 \cos 286°51'00'' = 2000.000$ m.

x of B $= 2033.000 + 31.892 \sin 37°35'28'' = 2052.455$ m.

y of B $= 1990.000 + 31.892 \cos 37°35'28'' = 2015.271$ m.

x of C $= 2033.000 + 38.286 \sin 90°27'56'' = 2071.285$ m

y of C $= 1990.000 + 38.286 \cos 90°27'56'' = 1989.689$ m.

x of D $= 2033.000 + 30.916 \sin 156°26'49'' = 2045.245$ m.

y of D $= 1990.000 + 30.916 \cos 156°26'49'' = 1959.945$ m.

x of E $= 2033.000 + 32.585 \sin 247°28'43'' = 2002.900$ m.

y of E $= 1990.000 + 32.585 \cos 247°28'43'' = 1977.519$ m.

b)

$$\text{Length of BC} = \sqrt{(\Delta x)^2 + (\Delta y)^2} = \sqrt{(2071.285 - 2052.455)^2 + (1989.689 - 2015.271)^2}$$

$$= \sqrt{(18.830)^2 + (-25.582)^2}$$

$$= \underline{31.765 \text{ m.}} \quad \text{ANS.}$$

$$\text{Azimuth of BC} = \tan^{-1}\frac{\Delta x}{\Delta y} = \frac{18.830}{-25.582} = 143.645° = \underline{143°38'40.3''} \quad \text{ANS.}$$

- END -