University Of Technology
Building and Construction Eng. Dept.
Final Exam 1st Attempt – 2015/2016
Subject :Land Surveying
Class: 3ed
Branch : Geomatic Engineering
Time : 3 hours.
Examiner : Tariq Naji
Date :13/6/2016

Answer Four Questions

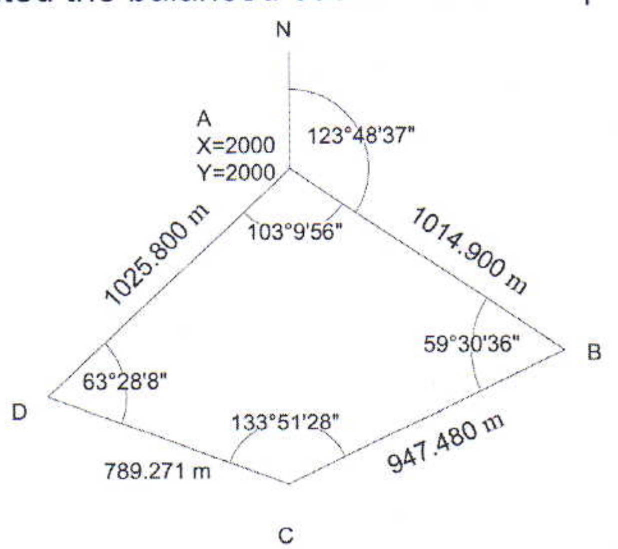
Q1) The following table represent the field data of profile leveling along a center line of irrigation channel.

Station	B.S	I.F.S	Distances			Ground Elevation	Grade Elevation
			L	CL	R		
$B.M_1$	0.536					77.200	
		1.265		0+00			73.971
		2.124	2.50				
		1.492	5.00				
		1.994			2.50		
		2.179			5.00		
		1.488		1+00			
		2.882	2.50				
		1.691	5.00				
		1.594			2.50		
		2.421			5.00		

If the grade slope is +0.01 % , channel width =5 m and side slope = 1:1.5,

1. Draw the cross sections with scale 1/100 **15 marks**
2. Compute the area of cross sections **7 marks**
3. Compute the depth of cut and/or fill for all stations **3 marks**

Q2) For the following figure balance the departures and latitudes using the compass rule and computed the balanced coordinates of all points.



25 marks

Q3) Answer two of the following: **12.5 marks each**

A) In triangulation systems what are the types of layouts, explain with figures.

B) Reciprocal leveling was conducted across a wide valley to determine the difference in level of points *A* and *B*, *A* situated on one side of the valley and *B* situated on the other. The following results on the staff held vertically at *A* and *B* from level stations 1 and 2, respectively, were obtained. The level station 1 was near to *A* and station 2 was near to *B*. If the elevation of *B* is 400.487 m above the MSL, what is the elevation of point *A*?

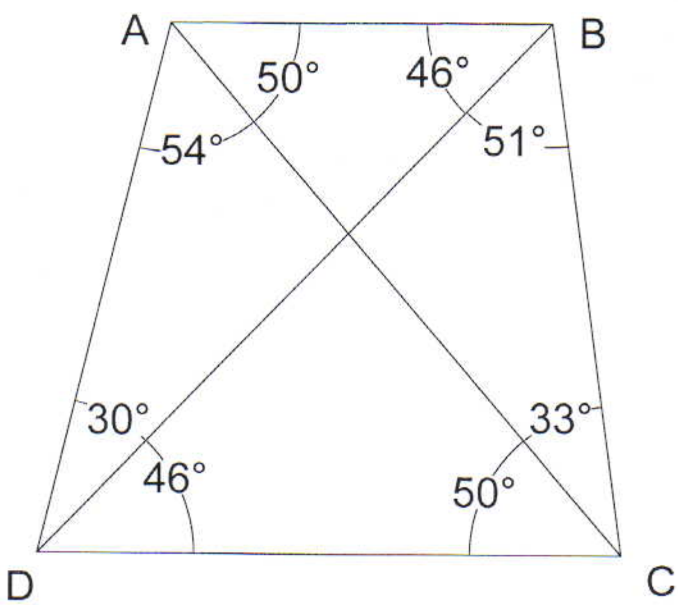
Instrument at	Staff reading on	
	A	B
1	1.641	2.193
2	2.141	2.701

C) A steel tape standardized at 20°C, the tape had a weight of 0.03967 kg/m. This tape was held horizontally, supported at the ends only, with a constant tension of 9.09 kg, to measure a line from *A* to *B*, D_{AB}=50.205. Apply corrections for tape sag, to determine the correct length of the line.

Q4) For the following figure ABCD:

A) Compute the strength of the figure *ABCD* for all the routes by which the length *CD* can be computed from the known side *AB*. Assume that all the stations were occupied. **15 marks**

B) If the horizontal coordinates of point A=(X_A=10000 m, Y_A=10000 m), length of line AB =D_{AB}=5000 m and Az of AB= Az_{AB}= 190°.Compute the horizontal coordinates of the triangulation network using Δ^s ***having the lowest value of R.*** **10 marks**



Q5) A) List the typical total station programs **9 marks**

B) Using a programmed total station: **16 marks**

1- How would the surveyor can determine the heights of inaccessible points.

2- How would you find the center location of a concrete column.

Table 1.2 Values of $\delta_A^2 + \delta_A\,\delta_B + \delta_B^2$

	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
0																							
10	428	359																					
12	359	295	253																				
14	315	253	214	187																			
16	284	225	187	162	143																		
18	262	204	168	143	126	113																	
20	245	189	153	130	113	100	91																
22	232	177	142	119	103	91	81	74															
24	221	167	134	111	95	83	74	67	61														
26	213	160	126	104	89	77	68	61	56	51													
28	206	153	120	99	83	72	63	57	51	47	43												
30	199	148	115	94	79	68	59	53	48	43	40	33											
35	188	137	106	85	71	60	52	46	41	37	33	27	23										
40	179	129	99	79	65	54	47	41	36	32	29	23	19	16									
45	172	124	93	74	60	50	43	37	32	28	25	20	16	13	11								
50	167	119	89	70	57	47	39	34	29	26	23	18	14	11	9	8							
55	162	115	86	67	54	44	37	32	27	24	21	16	12	10	8	7	5						
60	159	112	83	64	51	42	35	30	25	22	19	14	11	9	7	5	4	4					
65	155	109	80	62	49	40	33	28	24	21	18	13	10	7	6	5	4	3	2				
70	152	106	78	60	48	38	32	27	23	19	17	12	9	7	5	4	3	2	2	1			
75	150	104	76	58	46	37	30	25	21	18	16	11	8	6	4	3	2	2	1	1	1		
80	147	102	74	57	45	36	29	24	20	17	15	10	7	5	4	3	2	1	1	1	0	0	
85	145	100	73	55	43	34	28	23	19	16	14	10	7	5	3	2	2	1	1	0	0	0	0
90	143	98	71	54	42	33	27	22	19	16	13	9	6	4	3	2	1	1	1	0	0	0	0
95	140	96	70	53	41	32	26	22	18	15	13	9	6	4	3	2	1	1	0	0	0	0	
100	138	95	68	51	40	31	25	21	17	14	12	8	6	4	3	2	1	1	0	0	0		
105	136	93	67	50	39	30	25	20	17	14	12	8	5	4	2	2	1	1	0	0			
110	134	91	65	49	38	30	24	19	16	13	11	7	5	3	2	2	1	1	1				
115	132	89	64	48	37	29	23	19	15	13	11	7	5	3	2	2	1	1					
120	129	88	62	46	36	28	22	18	15	12	10	7	5	3	2	2	1						
125	127	86	61	45	35	27	22	18	14	12	10	7	5	4	3	2							
130	125	84	59	44	34	26	21	17	14	12	10	7	5	4	3								
135	122	82	58	43	33	26	21	17	14	12	10	7	5	4									
140	119	80	56	42	32	26	20	17	14	12	10	8	6										
145	116	77	55	41	32	25	21	17	15	13	11	9											
150	112	75	54	40	32	26	21	18	16	15	13												
152	111	75	53	40	32	26	22	19	17	16													
154	110	74	53	41	33	27	23	21	19														
156	108	74	54	42	34	28	25	22															
158	107	74	54	43	35	30	27																
160	107	74	56	45	38	33																	
162	107	76	59	48	42																		
164	109	79	63	54																			
166	113	86	71																				
168	122	98																					
170	143																						

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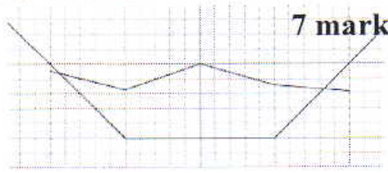
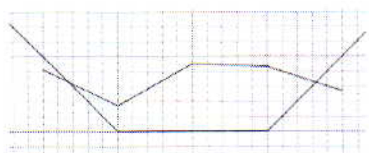
			L	CL	R			
$B.M_1$	0.536					77.200		
		1.265		0+00		76.471	73.971	2.5
		2.124	2.50			75.612		1.641
		1.492	5.00			76.244		2.273
		1.994			2.50	75.742		1.771
		2.179			5.00	75.557		1.586
		1.488		1+00		76.248	73.981	2.267
		2.882	2.50			74.854		0.873
		1.691	5.00			76.045		2.064
		1.594			2.50	76.142		2.161
		2.421			5.00	75.315		1.334

If the grade slope is +0.01 % , channel width =5 m and side slope = 1:1,

1. Draw the cross sections with scale 1/100 **15 marks**

7 marks





2. Compute the area of cross sections

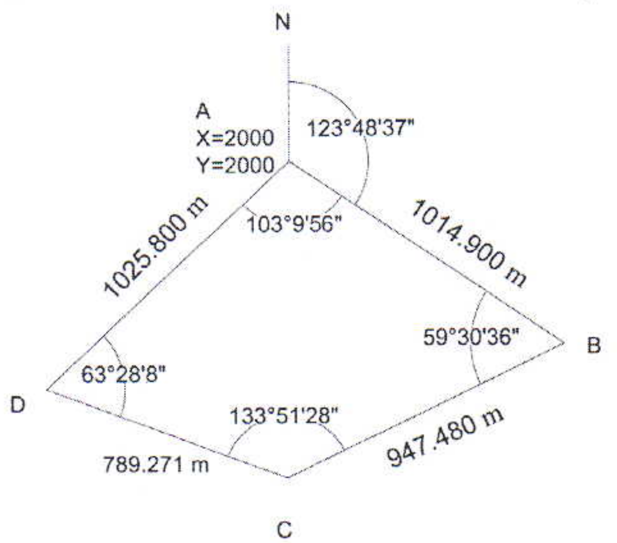
3 marks

13.771 m^2
11.94 m^2

3. Compute the depth of cut and/or fill for all stations

Depth
2.5
1.641
2.273
1.771
1.586
2.267
0.873
2.064
2.161
1.334

Q2) For the following figure balance the departures and latitudes using the compass rule and computed the balanced coordinates of all points.



25 marks

$$\sum \textit{The theoretical sum of interior angles} = (n-2)180° = (4-2)180° = 360°$$

$$T.C\ \textit{for interior angles} = \sum Theor. - \sum Meas. = 360° - 360°00'08" = -8"$$

$$\textit{Correction for single angle} = \frac{T.C.\ \textit{for Interior angles}}{n} = \frac{-8}{4} = -2"$$

Point	Interior angle	Correction	Corrected interior angle
A	$103°\,09'\,56"$	$-2'$	$103°\,09'\,54"$
B	$59°\,30'\,36"$	$-2'$	$59°\,30'\,34"$
C	$133°\,51'\,28"$	$-2'$	$133°\,51'\,26"$
D	$63°\,28'\,08"$	$-2'$	$63°\,28'\,06"$
	$\sum Meas. = 360°00'08"$	$\sum -20'$	$\sum 360°\,00'\,00"$

Computations of Azimuths

Sides	Azimuth

AB	$123° 48' 37"$
BC	$244° 18' 03"$
CD	$290° 26' 37"$
DA	$46° 58' 31"$

point	Line	Az.	Length (m)	ΔX (m)	ΔY (m)	Corr ΔX	Corr ΔY
A							
	AB	$123° 48' 37"$	1014.9	843.264	-564.735	0.035	0.002
B							
	BC	$244° 18' 03"$	947.48	-853.758	-410.870	0.033	0.002
C							
	CD	$290° 26' 37"$	789.271	-739.559	275.680	0.027	0.002
D							
	DA	$46° 58' 31"$	1025.80	749.920	699.917	0.036	0.002
A							
			3777.451	-0.133	-0.008		

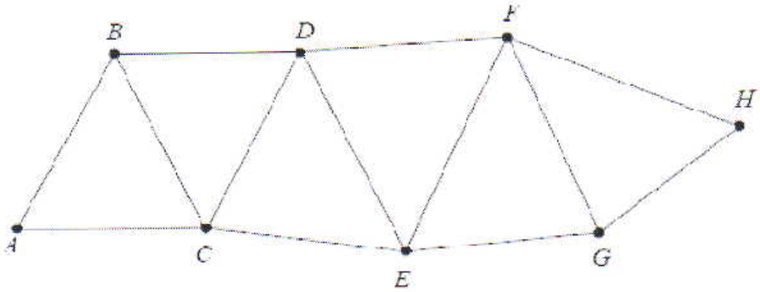
point	Line	Bal. ΔX (m)	Bal. ΔY (m)	X	Y
A				2000	2000
	AB	843.299	-564.733		
B				2843.299	1435.267
	BC	-853.725	-410.868		
C				1989.574	1024.399
	CD	-739.532	275.682		
D				1250.042	1300.081
	DA	749.956	699.919		
A				1999.998	2000

Q3) Answer two of the following: **12.5 marks each**

A) In triangulation systems what are the types of layouts, explain with figures.

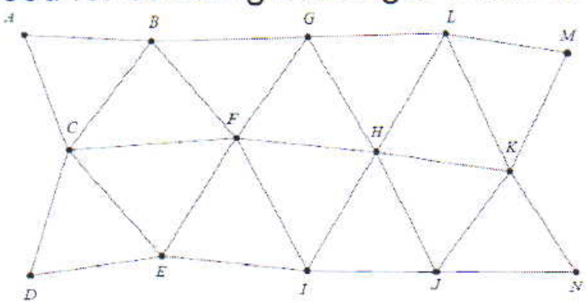
Single chain of triangles

When the control points are required to be established in a narrow strip of terrain such as a valley between ridges, a layout consisting of single chain of triangles is generally used as shown in following figure.



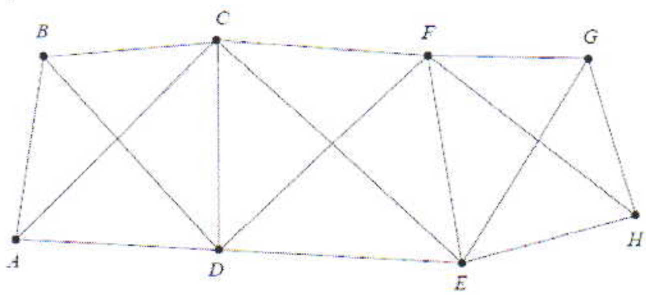
Double chain of triangles

A layout of double chain of triangles is shown in following Fig. This arrangement is used for covering the larger width of a belt.



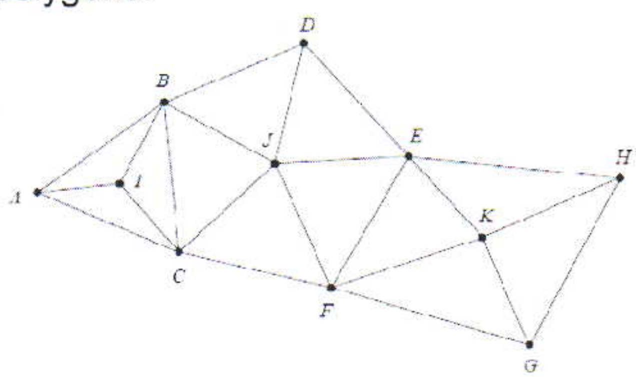
Braced quadrilaterals

A triangulation system consisting of figures containing four corner stations and observed diagonals shown in following Fig., is known as a layout of braced quadrilaterals.



Centered triangles and polygons

A triangulation system which consists of figures containing interior stations in triangle and polygon as shown in following Fig., is known as centered triangles and polygons.



A combination of all above systems

Sometimes a combination of above systems may be used which may be according to the shape of the area and the accuracy requirements.

B) Reciprocal leveling was conducted across a wide valley to determine the difference in level of points *A* and *B*, *A* situated on one side of the valley and *B* situated on the other. The following results on the staff held vertically at *A* and *B* from level stations 1 and 2, respectively, were obtained. The level station 1 was near to *A* and station 2 was near to *B*. If the elevation of *B* is 400.487 m above the MSL, what is the elevation of point *A*?

Instrument at	Staff reading on	
	A	**B**
1	1.641	2.193
2	2.141	2.701

$$\Delta h = \frac{(a_1 - b_1) + (a_2 - b_2)}{2}$$

a1=1.641
a2= 2.141
b1=2.193
b2=2.701
Δh=-0.556 m

Elevation of *A* = Elevation of *B* – Δ*h*=400.487+0.556=401.043 m

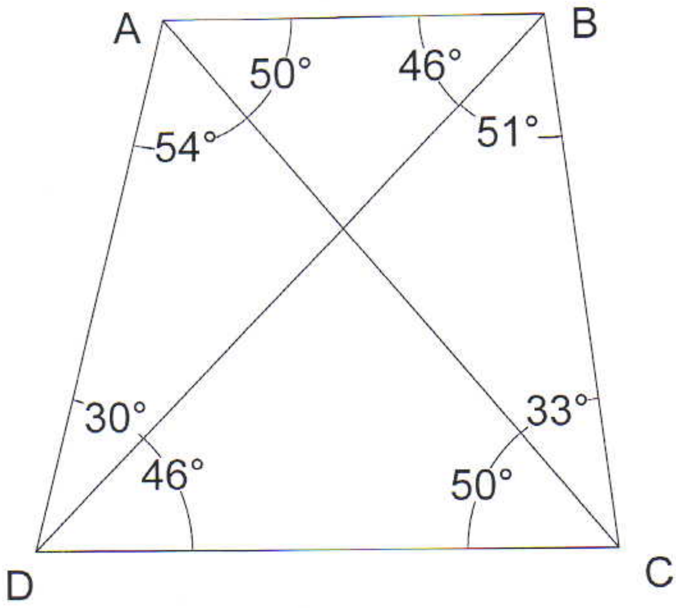
C) A steel tape standardized at 20°C, the tape had a weight of 0.03967 kg/m. This tape was held horizontally, supported at the ends only, with a constant tension of 9.09 kg, to measure a line from *A* to *B*, D_{AB}=50.205. Apply corrections for tape sag, to determine the correct length of the line.

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

$$C_s = -\left[\frac{(0.03967)^2 (50.205)^3}{24(9.09)^2}\right] = -0.100\, m$$

Q4) For the following figure ABCD:

A) Compute the strength of the figure *ABCD* for all the routes by which the length *CD* can be computed from the known side *AB*. Assume that all the stations were occupied. **15 marks**



$$R = \frac{D-C}{D} = \sum(\delta_A^2 + \delta_A\delta_B + \delta_A^2)$$
$n = 6$
$n' = 6$
$S = 4$
$S' = 4$
$D = 2 \times (n-1) = 2 \times (6-1) = 10$
$C = (n' - S' + 1) + (n - 2S + 3) = (6 - 4 + 1) + (6 - 2 \times 4 + 3) = 4$
$$\frac{D-C}{D} = \frac{10-4}{10} = 0.60$$

(*a*) Route-1, using Δ^s *ADC* and *ABC* with common side *AC*

For ΔADC the distance angles of *AD* and *AC* are 50° and 76° = 30° + 46°, respectively.

From Table 1.2,

$$\delta_{50}^2 + \delta_{50}\delta_{76} + \delta_{76}^2 = 4$$

For ΔABC, the distance angles of *AC* and *BC* are 97° = 51° + 46° and 50°

$$\delta_{97}^2 + \delta_{97}\delta_{50} + \delta_{50}^2 = 3$$
$$R = 0.6 * (4 + 3) = 4.2 \cong 4$$

(*b*) Route-2, using Δ^s *ADC* and *DCB* with common side *DC*

For ΔADC the distance angles of *AD* and *DC* are 50° and 54°, respectively.

$$\delta_{50}^2 + \delta_{50}\delta_{54} + \delta_{54}^2 = 8$$

For ΔDCB, the distance angle of *DC* and *CB* are 51° and 46°

$$\delta_{51}^2 + \delta_{51}\delta_{46} + \delta_{46}^2 = 11$$
$$R = 0.6 * (8 + 11) = 11.4 \cong 11$$

(*c*) Route-3, using Δ^s *ADB* and *ACB* with common side *AB*

From ΔADB the distance angles of *AD and AB* are 46° and 30°, respectively.

$$\delta_{46}^2 + \delta_{46}\delta_{30} + \delta_{30}^2 = 25$$

From ΔACB, the distance angles of *AB* and *CB* are 33° and 50°, respectively

$$\delta_{33}^2 + \delta_{50}\delta_{33} + \delta_{50}^2 = 20$$

$$R = 0.6 * (25 + 20) = 27$$

(*d*) Route-4, using Δ^s *ADB* and *DCB* with common side *DB*.

From Δ*ADB*, the distance angles of *AD* and *DB* are 46° and 104° = 50° + 54°, respectively

$$\delta_{46}^2 + \delta_{46}\delta_{104} + \delta_{104}^2 = 4$$

From Δ*DCB*, the distance angles of *DB* and *CB* are 83° = 33° + 50° and 46°

$$\delta_{83}^2 + \delta_{83}\delta_{46} + \delta_{46}^2 = 5$$

$$R = 0.6 * (4 + 5) = 5.4 \cong 5$$

B) If the horizontal coordinates of point A=(X_A=10000 m, Y_A=10000 m), length of line AB =D_{AB}=5000 m and Az of AB= Az_{AB}= 190°.Compute the horizontal coordinates of the triangulation network using Δ^s ***having the lowest value of R***.

10 marks

The lowest value of R is 4 for route 1

Δ^s *ADC* and *ABC* with common side *AC*

For Δ*ADC* the distance angles of *AD* and *AC* are 50° and 76° = 30° + 46°, respectively.

$$D_{AD} = \frac{D_{AB} * \sin 46}{\sin 30} = 7193.398\, m$$

$$D_{AC} = \frac{D_{AD} * \sin 76}{\sin 46} = 9702.957\, m$$

For Δ*ABC*, the distance angles of *AC* and *BC* are 97° = 51° + 46° and 50°

$$D_{BC} = \frac{D_{AC} * \sin 50}{\sin 76} = 7660.444\, m$$

$$Az_{AD} = 294^o$$
$$Az_{AC} = 240^o$$
$$X_D = X_A + \Delta X = 3428.504m$$
$$Y_D = Y_A + \Delta Y = 12925.818m$$
$$X_C = X_A + \Delta X = 1596.997m$$
$$Y_C = Y_A + \Delta Y = 5148.521m$$
$$X_B = X_A + \Delta X = 9131.759m$$
$$Y_B = Y_A + \Delta Y = 5075.961m$$

Q5) A) List the typical total station programs

16 marks

Point Location
Trigonometric Leveling
Missing Line Measurement **9 marks**
Resection
Azimuth
Remote Object Elevation
Distance Offset Measurements
Angle Offset Measurements
Layout or Setting-Out Positions

Area Computation

B) Using a programmed total station:

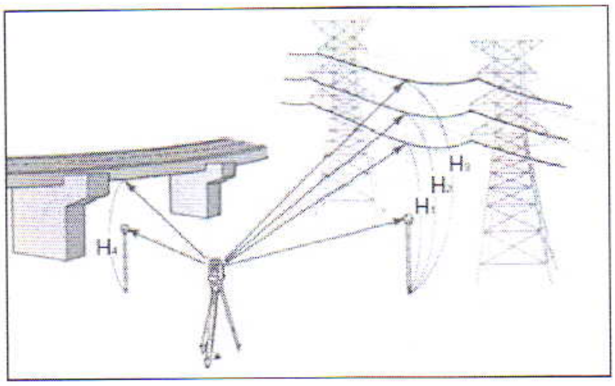
1- How would the surveyor can determine the heights of inaccessible points.

The surveyor can determine the heights of inaccessible points (e.g., electrical conductors, bridge components) by simply sighting the pole-mounted prism while it is held directly under the object. When the object itself is then sighted, the object height can be promptly displayed (the prism height must first be entered into the total station).

Known:
- N, E, and Z coordinates of the instrument station ($\overline{\wedge}$).
- N, E, and Z coordinates of a reference control point, or at least the azimuth of the line joining the instrument station and the control point.

Measured:
- Horizontal angle, or azimuth, from the reference control point (optional) and distance from the instrument station to the prism held directly below (or above) the target point.
- Vertical angles to the prism and to the target point hi and height of the prism.

Computed:
- Distance from the ground to the target point (and its coordinates if required).



2- How would you find the center location of a concrete column.

When the center of a solid object (e.g., a concrete column, tree) is to be located, its position can be ascertained by turning angles from each side to the centerpoint. The software then computes the center location of the measured solid object.

Known:
- N, E, and Z coordinates of the instrument station ($\overline{\wedge}$).
- N, E, and Z coordinates (or the azimuth) of the reference control point.

Measured:
- Angles from the prism being held on either side of the measuring point, to the target centerpoint. (The prism must be held such that both readings are the same distance from the instrument station—if both sides are measured).

Computed:
- N, E, and Z coordinates of the hidden measuring points.
- Azimuths and distance from the instrument station to the hidden measuring point.
- When the measuring point is to the center of a tree, some programs will use this application to determine tree's diameter and then to estimate the tree's height (knowing the height allows the CAD software to insert the correctly sized tree symbol on the digital drawing).