9 TRAVERSING

Asterisks (*) indicate problems that have partial answers given in Appendix G.

9.1 How is angular closure achieved in a polygon traverse?

From Section 9.7, paragraph 1: "The angular misclosure for an interior-angle traverse is the difference between the sum of the measured angles and the geometrically correct total for the polygon. The sum, Σ, of the interior angles of a closed polygons should be

$$\Sigma = (n - 2)180^{\circ}$$

where n is the number of sides, or angles, in the polygon."

9.2 List the disadvantages of an open traverse.

From Section 9.1, paragraph 4: "*Open traverse should be avoided because they offer no means of checking for observational errors or mistakes*."

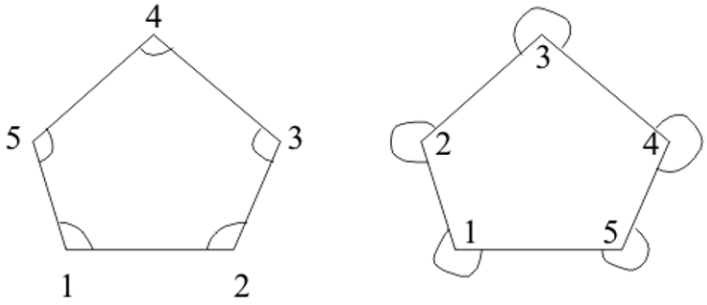
9.3 How can an angular closure be obtained on a link traverse?

From Section 9.7, paragraph 4: "A closed-polygon azimuth traverse is checked by setting up on the starting point a second time, after having occupied the successive stations around the traverse, and orienting by back azimuths. The azimuth of the first side is then obtained a second time and compared with its original value. Any difference is the misclosure. If the first point is not reoccupied, the interior angles computed from the azimuths will automatically check the proper geometric total, even though one or more of the azimuths may be incorrect."

9.4 In your own words define an angle to the right.

From Section 91.2.2: "Angles measured clockwise from a backsight on the "rearward" traverse station to a foresight on the "forward" traverse station are called *angles to the right*."

9.5 Draw two five-sided closed polygon traverses with station labels 1 to 5. The first traverse should show angles to the right that are interior angles, and the second should show angles to the right that are exterior angles.



9.6 List four pertinent considerations in selecting locations for traverse stations.

From Section 9.4, paragraph 1:

1. Accuracy
2. Utility
3. Efficiency
4. Intervisibility between stations.

"Of course, intervisibility between adjacent stations, forward and back, must be maintained for angle and distance measurements. The stations should also ideally be set in convenient locations that allow for easy access. Ordinarily, stations are placed to create lines that are as long as possible. This not only increases efficiency by reducing the number of instrument setups, but it also increases accuracy in angle measurements. Utility may override using very long lines, however, because intermediate hubs, or stations at strategic locations, may be needed to complete the survey's objectives."

9.7 How should traverse stations be referenced?

See Section 9.5.

9.8 Discuss the advantages and dangers of radial traversing.

From Section 9.9, the advantages are the several stations with known positions can be laid out quickly from one setup. However, the disadvantage is that these spur stations have no geometric or mathematical checks and thus should be resurveyed from a second station, which has coordinates derived from the first occupied station.

9.9 What should be the sum of the interior angles for a closed-polygon traverse that has: **(a)*** 6 sides **(b)** 10 sides **(c)** 15 sides.

From Equation (9.1):

(**a**)* 720°

(**b**) 1440°

(**c**) 2340°

9.10 What should the sum of the exterior angles for a closed-polygon traverse that are listed

in Problem 9.9.

From Equation (9.2):

(**a**) 1440°

(**b**) 2160°

(**c**) 3060°

9.11 Four interior angles of a six-sided polygon traverse were observed as; $A = 43°17'08''$, $B = 202°04'57''$, $C = 103°33'44''$, $D = 98°35'15''$, and $E = 132°23'59''$. The angle at F was not observed. If all observed angles are assumed to be correct, what is the value of angle *F*?

140°04'57"

9.12 Similar to Problem 9.11, except the traverse had seven sides with observed angles of $A = 158°15'44''$, $B = 235°05'44''$, $C = 66°14'26''$, $D = 111°26'53''$, $E = 133°38'27''$, and $F = 141°20'36''$. Compute the angle at G, which was not observed.

53°58'10"

9.13 What is the angular misclosure of a six-sided polygon traverse with observed angles of $98°10'10''$, $133°45'58''$, $68°23'10''$, $182°50'54''$, $134°32'02''$, and $102°17'36''$.

10"

9.14 What FGCS standard would the angular misclosure in Problem 9.13 meet?

2nd order, class II; $c = 10''/\sqrt{6} = 4.1''$; allowable by 2nd order, class II is 4.5"

9.15* According to FGSC standards, what is the maximum acceptable angular misclosure for a second order, class I traverse having 20 angles?

13"; by Equation (9.3) using $K = 3''$

9.16* What is the angular misclosure for a five-sided polygon traverse with observed exterior angles of $252°26'37''$, $255°55'13''$, $277°15'53''$, $266°35'02''$, and $207°47'05''$?

10"

9.17 What is the angular misclosure for a five-sided polygon traverse with observed interior angles of $92°26'47''$, $109°55'03''$, $137°15'33''$, $106°35'22''$, and $93°47'20''$?

5"; Σangles = 540°00'05"

9.18 Discuss how a data collector can be used to check the setup of a total station in traversing.

From Section 9.8, paragraph 4: "Mistakes in orientation can be minimized when a data collector is used in combination with a total station. In this process, the coordinates of

each backsight station are checked before proceeding with the angle and distance observations to the next foresight station. For example in Figure 9.1(a), after the total station is leveled and oriented at station *B,* an observation is taken "back" on *A.* If the newly computed coordinates of *A* do not closely match their previously stored values, the instrument setup, leveling, and orientation should be rechecked, and the problem resolved before proceeding with any further measurements. This procedure often takes a minimal amount of time and typically identifies most field mistakes that occur during the observational process."

9.19* If the standard error for each measurement of a traverse angle is ±3.3″, what is the expected standard error of the misclosure in the sum of the angles for a eight-sided traverse?

±9.3"; by Equation (3.12)

9.20 If the angles of a traverse are turned so that the 95% error of any angle is ±3.5″, what is the 95% error in a twelve-sided traverse?

±23.8"; by Equation (3.12) using an E_{95} multiplier of 1.96

9.21 What criteria should be used when making reference ties to traverse stations?

From Section 9.5, paragraph 2: "As illustrated, these ties consist of distance observations made to nearby fixed objects. Short lengths (less than 100 ft) are convenient if a steel tape is being used, but, of course, the distance to definite and unique points is a controlling factor. Two ties, preferably at about right angles to each other, are sufficient, but three should be used to allow for the possibility that one reference mark may be destroyed. Ties to trees can be observed in hundredths of a foot if nails are driven into them. However, *permission must be obtained from the landowner before driving nails into trees*."

9.22* The azimuth from station *A* of a link traverse to an azimuth mark is $212°12'36''$. The azimuth from the last station of the traverse to an azimuth mark is $192°12'16''$. Angles to the right are observed at each station: $A = 136°15'40''$, $B = 119°15'36''$, $C = 93°48'54''$, $D = 136°04'16''$, $E = 108°30'10''$, $F = 42°48'03''$, and $G = 63°17'16''$. What is the angular misclosure of this link traverse?

14"

$Az_{A\text{-}Mk}$	212°12'36"	*DC*	21°32'46"
+*A*	+136°15'40"	+*D*	+136°04'16"
AB	348°28'16"	*DE*	157°37'02"
	–180°		+180°
BA	168°28'16"	*ED*	337°37'02"
+*B*	+119°15'36"	+*E*	+108°30'10"
BC	287°43'52"	*EF*	446°07'12"
	–180°		–180°
CB	107°43'52"	*FE*	266°07'12"

$+C$	$\underline{+93°48'54"}$	$+F$	$\underline{+42°48'02"}$
CD	$201°32'46"$	FG	$308°55'14"$
	$\underline{-180°}$		$\underline{-180°}$
DC	$21°32'46"$	GF	$128°55'14"$
		$+G$	$\underline{+63°17'16"}$
		$Az_{G\text{-}Mk}$	$192°12'30"$

Misclosure = 192°12'30" − 192°12'16" = 14"

9.23 What FGCS order and class does the traverse in Problem 9.22 meet?

Third order, Class I; By Equation (9.3): $K = \frac{14"}{\sqrt{7}} = 5.3''$; allowable $10''$

9.24* The interior angles in a five-sided closed-polygon traverse were observed as $A = 108°28'36''$, $B = 110°26'54''$, $C = 106°25'58''$, $D = 102°27'02''$, and $E = 116°11'15''$. Compute the angular misclosure. For what FGCS order and class is this survey adequate?

−15"; Third order, Class I; By Equation (9.3): $K = 15"/\sqrt{5} = 6.7"$, allowable 10"

9.25 Similar to Problem 9.24, except for a six-sided traverse with observed exterior angles of $A = 244°28'36''$, $B = 238°26'54''$, $C = 246°25'58''$, $D = 234°27'02''$, $E = 235°08'55''$, and $F = 241°02'45''$.

10"; Second order, Class II, By Equation (9.3): $K = 10"/\sqrt{5} = 4.1"$; allowable 4.5"

9.26 In Figure 9.6, what is the average interior angle with the instrument at station 101.

82°18'18"; $\frac{82°18'19" + (262°18'18" - 180°)}{2} = 82°18'18.5"$

9.27 Same as Problem 9.26 except at instrument station 102.

95°32'06"; $\frac{95°32'10 + (275°32'08 - 180°00'02")}{2} = 95°32'06"$

9.28 Explain why it is advisable to use two instrument stations, as O and O' in Figure 9.7(b), when running radial traverses.

From Section 9.9, paragraph 2: To provide checks in computed positions for observed stations.