Ferris State University

Surveying Engineering

Surveying Computation - SURE 215

P R O B L E M N U M B E R 1098

Designed by: S.R. Hashimi

Traverse Computation

Write your answers in the spaces provided

Given Data:

Northing For Point No. 1 = 7139.137 Easting For Point No. 1 = 7881.057

Azimuth From Point 1 To Azimuth Mark 1 = 99 43 31.9

Angle Codes: R = Angle Right, L = Angle Left, D = Deflection Angle

POINT NO.	DISTANCE	ANGLE in DMS	ANGLE CODE
Az. Mark No. 1			
1		99 36 15	R
	400.852		
2		98 4 13	R
	525.360		
3		110 16 34	R
	514.888		
4		101 40 13	R
	542.458		
5		96 48 4	R
	478.667		
1		33 35 59	R
Az. Mark No. 1			

Compute:

(a) Angular Error of Closure = _____

(b) Preliminary Adjusted Azimuths - Prepare A Table For This

(c) Unadjusted Latitudes and Departures - Prepare A Table For This

(d) Error in Latitude = _____, Error in Departure = _____

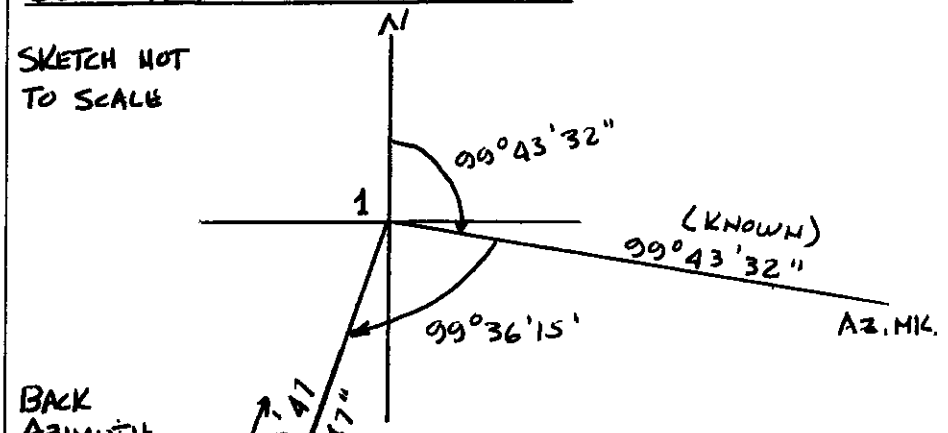
(e) Total Linear Error and its Direction (Azimuth) = _____

(f) Relative Error of Closure = _____

(g) Final Adjusted Traverse (Distances, Azimuths, and Coordinates) Using Transit Rule - Prepare A Table For This

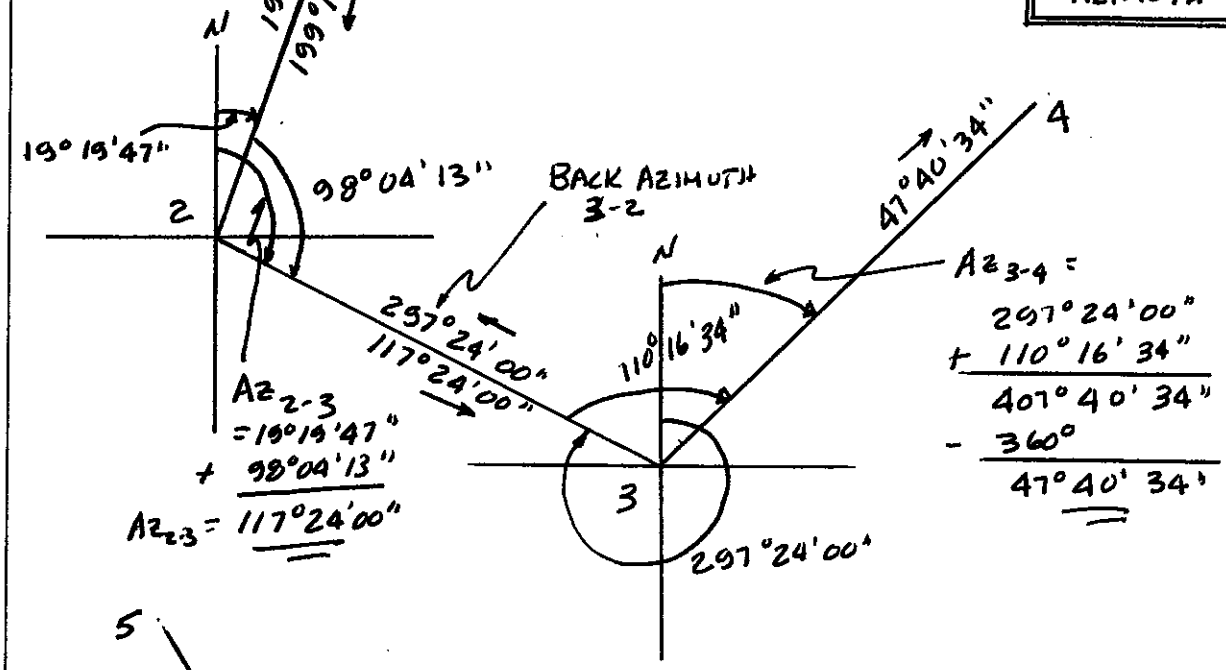
(h) Compute The Area by DMD and Check by Coordinates = _____

COMPUTATION OF DIRECTIONS



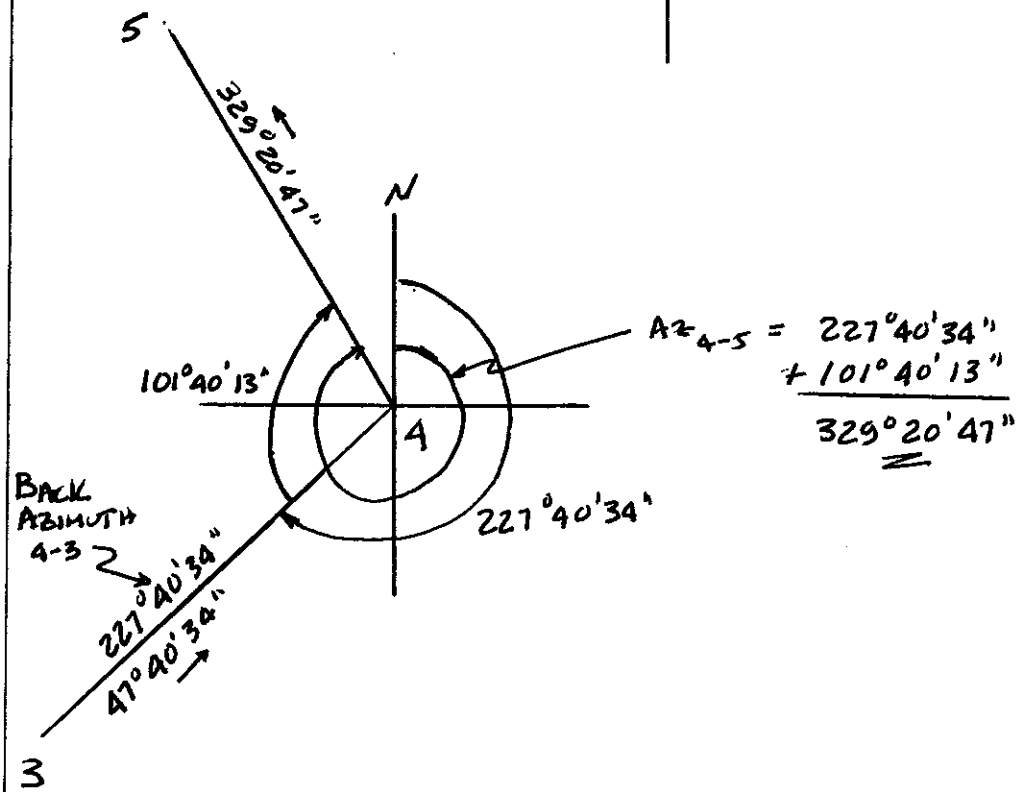
$Az_{1\text{-}Az.MK} = 99°43'32"$
$+ \measuredangle_{Az.MK\text{-}2} = 99°36'15"$
$Az_{1\text{-}2} = 199°19'47"$

BACK AZIMUTH IS 180° DIFFERENT FROM FORWARD AZIMUTH

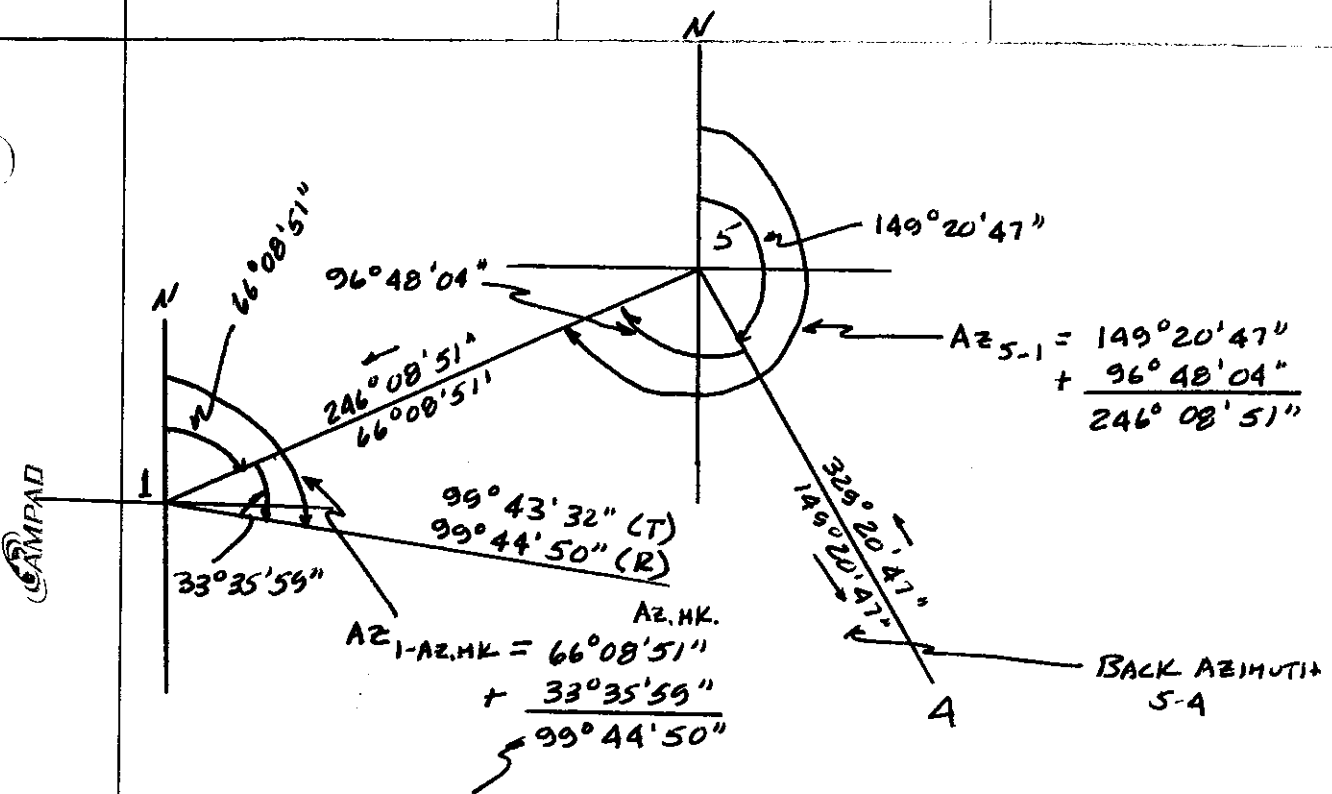


$Az_{2\text{-}3} = 19°19'47" + 98°04'13"$
$Az_{2\text{-}3} = 117°24'00"$

$Az_{3\text{-}4} = 297°24'00" + 110°16'34"$
$= 407°40'34" - 360°$
$= 47°40'34"$



$Az_{4\text{-}5} = 227°40'34" + 101°40'13"$
$= 329°20'47"$



AZIMUTH IS RECORDED VALUE DERIVED FROM MEASURED (UNADJUSTED) ANGLES

COMPUTE ANGULAR ERROR OF CLOSURE:

$$E_\measuredangle = R - T = (99°44'50") - (99°43'32")$$
$$= 0°01'18" \quad \text{OR} \quad \underline{\underline{78"}}$$

CORRECTION PER ANGLE:

$$CPA = -\frac{E_\measuredangle}{n} = -\frac{78"}{6} = -13"$$

APPLY CPA TO AZIMUTHS TO ARRIVE AT THE PRELIMINARY ADJUSTED AZIMUTHS. NOTE THAT WHEN ADJUSTING AZIMUTHS, THE CORRECTIONS ARE APPLIED CUMULATIVELY

LINE	AZIMUTH	CORRECTION	PRELIMINARY ADJUSTED AZIMUTHS
1-Az.MK	99° 43' 32"	0"	99° 43' 32" (FIXED)
1-2	199° 19' 47"	-13"	199° 19' 34"
2-3	117° 24' 00"	-26"	117° 23' 34"
3-4	47° 40' 34"	-39"	47° 39' 55"
4-5	329° 20' 47"	-52"	329° 19' 55"
5-1	246° 08' 51"	-1'05"	246° 07' 46"
1-Az.MK	99° 44' 50"	-1' 18"	99° 43' 32" ✓ (check)

COMPUTE THE LATITUDES AND DEPARTURES

$LAT_{1-2} = \Delta_{1-2} \cos \alpha_{1-2} = 400.852' \cos(199°19'34") = -378.264'$

$DEP_{1-2} = \Delta_{1-2} \sin \alpha_{1-2} = 400.852' \sin(199°19'34") = -132.660'$

$LAT_{2-3} = 525.360' \cos(117°23'34") = -241.712'$

$DEP_{2-3} = 525.360' \sin(117°23'34") = 466.453'$

$LAT_{3-4} = 514.888' \cos(47°39'55") = 346.757'$

$DEP_{3-4} = 514.888' \sin(47°39'55") = 380.617'$

etc. ... SEE TABLE

STA	DIRECTION	DISTANCE	LATITUDE	DEPARTURE
1				
	199°19'34"	400.852'	-378.264'	-132.660'
2				
	117°23'34"	525.360'	-241.712'	466.453'
3				
	47°39'55"	514.888'	346.757'	380.617'
4				
	329°19'55"	542.458'	466.588'	-276.688'
5				
	246°07'46"	478.667'	-193.703'	-437.723'
1				
		Σ 2,462.225'	- 0.334'	-0.001'

SUM OF ABSOLUTE VALUES OF LATITUDES: $\Sigma|LAT| = 1,627.024'$

SUM OF ABSOLUTE VALUES OF DEPARTURES: $\Sigma|DEP| = 1,694.141'$

LINEAR ERROR OF CLOSURE:

$$E_c = \sqrt{(\Sigma DEP)^2 + (\Sigma LAT)^2} = \sqrt{(-0.001)^2 + (-0.334)^2} = \sqrt{0.111557}$$

$$= 0.334'$$

AZIMUTH OF CLOSING LINE:

$$\beta_c = \tan^{-1}\left(\frac{\Sigma DEP}{\Sigma LAT}\right) = \tan^{-1}\left(\frac{-0.001'}{-0.334'}\right) = 180°10'18"$$

ACCURACY RATIO:

$$\text{Accuracy} = \frac{E_c}{P} = \frac{0.334'}{2462.225'} = \frac{1}{7,372} \text{ or } \underline{1:7,400}$$

ADJUSTMENT OF LATITUDES AND DEPARTURES USING TRANSIT RULE. CORRECTIONS:

$$C_{L_{1-2}} = \frac{cl_L}{\Sigma|LAT|} |\Delta_{LAT_{1-2}}| = \left(\frac{0.334'}{1627.024'}\right)(378.264') = 0.078'$$

$$C_{D_{1-2}} = \frac{cl_D}{\Sigma|DEP|} |\Delta_{DEP_{1-2}}| = \left(\frac{0.001'}{1694.141'}\right)(132.660') = 0.000'$$

$$C_{L_{2-3}} = \left(\frac{0.334'}{1627.024'}\right)(241.712') = 0.050'$$

$$C_{D_{2-3}} = \left(\frac{0.001'}{1694.141'}\right)(466.453') = 0.000'$$

SINCE THIS DEPARTURE IS THE LARGEST AND THERE IS NO CORRECTION AT 3 DECIMAL PLACES, NO NEED TO CALCULATE IT FOR THE OTHER DEPARTURES

CORRECTIONS TO LATITUDES & DEPARTURES ADDED TO PRELIMINARY VALUES TO ARRIVE AT THE ADJUSTED LATITUDES AND DEPARTURES - SEE TABLE.

STA	PRELIMINARY LATITUDE	PRELIMINARY DEPARTURE	CORRECTIONS TO LATITUDE	CORRECTIONS TO DEPARTURE	ADJUSTED LATITUDE	ADJUSTED DEPARTURE
1	-378.264'	-132.660'	+0.078'	0.000'	-378.186'	-132.660'
2	-241.712'	466.453'	+0.050'	0.000'	-241.662'	466.453'
3	346.757'	380.617'	+0.071'	0.000'	346.828'	380.617'
4	466.588'	-276.688' ~~-276~~	+0.096'	0.000'	466.684'	-276.688'
5	-193.703'	-437.723'	+0.040'	0.000'	-193.663'	-437.723'
1						
Σ	-0.334'	-0.001'	+0.335'	0.000'	0.001'	-0.001'

NOTE THAT SLIGHT ERRORS MAY STILL EXIST DUE TO ROUND-OFF EFFECTS AND SIGNIFICANT FIGURES.

COMPUTE THE NORTHING AND EASTING COORDINATES BY ADDING THE ADJUSTED LATITUDE & DEPARTURES AS FOLLOWS:

$N_2 = N_1 + LAT_{1-2} = 7,139.137' + (-378.186') = 6,760.951'$

$E_2 = E_1 + DEP_{1-2} = 7,881.057' + (-132.660') = 7,748.397'$

$N_3 = 6,760.951' + (-241.662') = 6,519.289'$

$E_3 = 7,748.397' + 466.453' = 8,214.850'$

etc. - see table

STA	LATITUDE	DEPARTURE	NORTHING	EASTING
1			7,139.137	7,881.057'
	-378.186'	-132.660'		
2			6,760.951	7,748.397'
	-241.662'	466.453'		
3			6,519.289'	8,214.850'
	346.828'	380.617'		
4			6,866.117'	8,595.467'
	466.684'	-276.688'		
5			7,332.801'	8,318.774'
	-193.663'	-437.723'		
1			7,139.138'	7,881.056'

COMPUTE THE ADJUSTED DIRECTIONS (AZIMUTHS HERE) AND DISTANCES BASED ON THE ADJUSTED LATITUDES & DEPARTURES

RECALL THAT: $LAT_{1-2} = N_2 - N_1 = Y_2 - Y_1$

$DEP_{1-2} = E_2 - E_1 = X_2 - X_1$

$\alpha_{1-2} = \tan^{-1}\left(\frac{DEP_{1-2}}{LAT_{1-2}}\right) = \tan^{-1}\left(\frac{-132.660'}{-378.186'}\right) = 199°19'47''$

$DIST_{1-2} = \left[(DEP_{1-2})^2 + (LAT_{1-2})^2\right]^{1/2} = \left[(-132.660')^2 + (-378.186')^2\right]^{1/2}$

$= 400.778'$

$\alpha_{2-3} = \tan^{-1}\left(\frac{466.453'}{-241.662'}\right) = 117°23'17''$

$DIST_{2-3} = \left[(466.453)^2 + (-241.662)^2\right]^{1/2} = 525.337'$

etc...

STA	LATITUDE	DEPARTURE	ADJUSTED DIRECTION	DISTANCE
1	-378.186'	-132.660'	199°19'47"	400.778'
2	-241.662'	466.453'	117°23'17"	525.337'
3	346.828'	380.617'	47°39'34"	514.936'
4	466.684'	-276.688'	329°20'14"	542.541'
5	-193.663'	-437.723'	246°08'02"	478.651'
1				

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AREA CALCULATIONS BY COORDINATES

7,139.137	7,881.057
6,760.951	7,748.397
6,519.289	8,214.850
6,866.117	8,595.467
7,332.801	8,318.774
7,139.138	7,881.056

SUM 1 - SOLID LINES
SUM 2 - DASHED LINES

SUM 1 = 281,801,290.398
SUM 2 = 282,619,361.058
2A = 818,036.33

AREA = 409,018.165 sq ft
= 9.39 ac

AREA BY DMD

LINE	DEPARTURE	LATITUDE	DMD	DOUBLE AREA
1-2	-132.660'	-378.186'	-132.660'	50,170.1548
2-3	466.453'	-241.662'	201.133'	-48,606.2030
3-4	380.617'	346.828'	1,048.203'	363,546.1501
4-5	-276.688'	466.684'	1,152.132'	537,681.5703'
5-1	-437.723'	-193.663'	437.721'	-84,770.3620'

2A = 818,021.3101

A = 409,010.655 sq ft
= 9.39 ac

SLIGHT DIFFERENCES IN BOTH AREAS DUE TO ROUND-OFF AND SIGNIFICANT FIGURES.

Name: TRANSIT RULE EXAMPLE			Traverse Adjustment Form						Date:		Page 1 of 1	
			Preliminary		Corrections to		Adjusted		Coordinates		Adjusted	
Station	Direction	Distance	Latitude	Departure	Latitude	Departure	Latitude	Departure	Northing	Easting	Direction	Distance
1									7,139.137	7,881.057		
	199-19-34	400.852	-378.264	-132.660	0.078	0.000	-378.186	-132.660			199-19-47	400.778
2									6,760.951	7,748.397		
	117-23-34	525.360	-241.712	466.453	0.050	0.000	-241.662	466.453			117-23-17	525.337
3									6,519.289	8,214.850		
	47-39-55	514.988	346.757	380.617	0.071	0.000	346.828	380.617			47-39-34	514.936
4									6,866.117	8,595.467		
	329-19-55	542.458	466.580	-276.688	0.056	0.000	466.684	-276.688			329-20-14	542.541
5									7,332.801	8,318.779		
	246-07-46	478.667	-193.703	-437.723	0.040	0.000	-193.663	-437.723			246-08-02	478.651
1									7,139.138	7,881.056		
	Σ	2462.225	-0.334	-0.001	0.335	0.000	0.001	-0.001				
ALL DISTANCES IN FEET												

Traverse Adjustment Program				Transit Rule								
		Azimuth										
							Corrections to		Corrected	Corrected		
Sta	Dist	Deg	Min	Sec	Departure	Latitude	Departure	Latitude	Departure	Latitude	Easting	Northing
1											7881.057	7139.137
	400.852	199	19	34	-132.660	-378.264	0.000	0.078	-132.660	-378.186		
2											7748.397	6760.951
	525.360	117	23	34	466.453	-241.712	0.000	0.050	466.453	-241.662		
3											8214.851	6519.288
	514.888	47	39	55	380.617	346.757	0.000	0.071	380.617	346.828		
4											8595.468	6866.116
	542.458	329	19	55	-276.688	466.588	0.000	0.096	-276.688	466.684		
5											8318.780	7332.800
	478.667	246	7	46	-437.723	-193.703	0.000	0.040	-437.723	-193.663		
1											7881.057	7139.137
Σ	2462.225				0.000	-0.334	0.000	0.334	0.000	0.000		

										Linear Error:		
		Adjusted									0.334	
	Adjusted	Azimuth				Area Calculations						
Sta	Distance	Deg	Min	Sec		DMD	2A		Coordinates		Accuracy Ratio	
1									53283437.	55316870.	1 /	7372.775
	400.779	199	19	47.2		-132.66	50170.1116					
2									50514037.	55540198.		
	525.337	117	23	16.7		201.13	-48606.421					
3									56404120.	56036333.		
	514.936	47	39	33.9		1048.20	363546.525					
4									63028847.	57117710.		
	542.540	329	20	13.6		1152.13	537682.054					
5									59388908.	57790217.		
	478.651	246	8	1.7		437.72	-84770.796					
1												
						Double Area =	818021.473		Double Area =	818021.473		
						Area =	409010.737		Area =	409010.737		
							9.39			9.39		