004080 PROGRAM SUBMITTAL

☒ New Program ☐ Revision to Program

Model No. ☐ 67 ☐ 97 ☒ 41C

Program Title AREA OF LAND BY POINT-TO-POINT TRAVERSING

No. of Steps/Lines 138 Category No. 470

Category Name SURVEYING

Abstract — 50 Word Maximum This program computes the area of land by point-to-point traversing, given the bearing, distance, and radius of curvature of each side. The error in closure is displayed as well as the area in square feet and acres. Bearings and quadrants are previewed and may be changed.

Necessary Accessories: None required.

Name Gary Goodman

Company OSU Instruction and Research Computer Center

Address 406 Baker Systems Engr. Bldg., 1971 Neil Avenue

City Columbus State/Country Ohio/U.S.A. Zip Code 43210

Phone Number (614) 422-7384

4/28 B

If my program is accepted, my bonus choice is:

☐ FOUR PROGRAMS OR ☒ CREDIT FOR FOUR PROGRAMS*

* No partial credit will be given. Select all four programs at the same time.

Submittal Checklist: Please use the checklist below to insure submittal of all proper program documentation.

☒ Program Submittal	☒ Program Description II	☒ Program Listing(s)	☒ Registers, Status ...
☒ Program Description I	☒ User Instructions	☒ Magnetic Card(s)	☒ Keyboard, Card Labeling (optional)

ACKNOWLEDGMENT AND AGREEMENT

To the best of my knowledge, I have the right to contribute this program material without breaching any obligation concerning nondisclosure of proprietary or confidential information of other persons or organizations. I am contributing this program material on a nonconfidential nonobligatory basis to Hewlett-Packard Company ("HP") for inclusion in its program library, and I agree that HP may use, duplicate, modify, publish, and sell the program material, and authorize others to do so without obligation or liability of any kind. HP may publish my name and address, as the contributor, to facilitate user inquiries pertaining to this program material.

Signature Gary Goodman Date April 23, 1980

Received & approved – Thanks! Sandy Canning

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Necessary Accessories: A printer is optional

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2/17/81 B
12/12 B

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Signature Gary Goodman Date 12/8/80

PROGRAM DESCRIPTION I

Program Title AREA OF LAND BY POINT-TO-POINT TRAVERSING

Contributor's Name Gary Goodman

Address OSU IRCC, 406 Baker Systems Engr. Bldg., 1971 Neil Avenue

City Columbus **State/Country** Ohio/U.S.A. **Zip Code** 43210

Program Description, Equations, Variables This program computes the area of a plot of land by point-to-point traversing around the perimeter. At each point the user supplies the bearing (and quadrant) and the distance to the next point. If the side is curved, the radius of curvature is required. The bearing is reviewed and may be changed before final entry. Also a side may be restarted at anytime up until the next side is requested. The output consists of the closure error in feet, (The direction of the final point from the starting point may be obtained.), and the area in square feet and in acres.

The method and equations used are described on the following page.

Necessary Accessories None

Operating Limits and Warnings The arc of a curved side must be $\leq 180^{\circ}$.

Reference(s)

This program has been verified only with respect to the numerical example given in *Program Description II*. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

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The coordinates of each point along the traverse are found from the coordinates of the previous point by vector addition

$$x_i = x_{i-1} + d\cos\theta \qquad y_i = y_{i-1} + d\cos\theta$$

where d and θ are the distance and bearing of the new point relative to the previous point. In practice, bearings are usually specified in the range 0 to 90 degrees and in a particular quadrant, such as N 38° 17' 23" W. The program converts these bearings to angles on the full circle.

The area of any polygon can be readily found by first connecting one vertex (the starting point) with every other vertex of the polygon, and then summing the areas of the triangles thus formed, taking into account that when the angle, ϕ_i, to a vertex is less than the angle, ϕ_{i-1}, to the previous vertex, the area is to be considered negative. See Figure 1.

Figure 1.

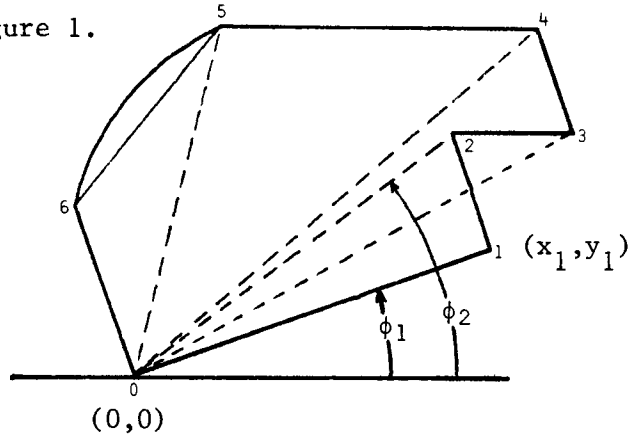
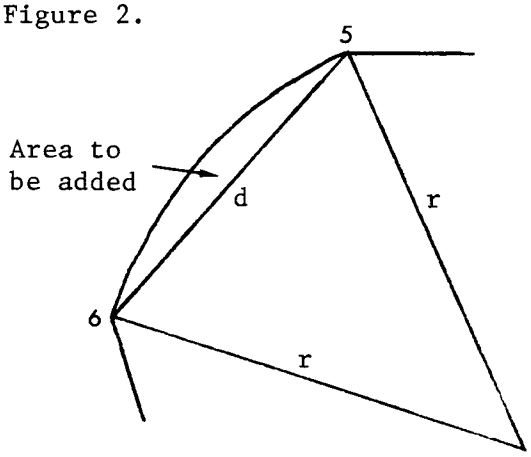


Figure 2.



The area of triangle (0,1,2) is

$$\tfrac{1}{2}(x_1y_2 - x_2y_1)$$

This formula automatically gives the proper sign for inclusion into the total area.

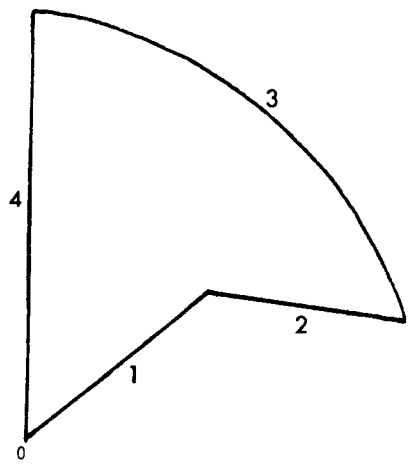
If the side is curved, the area which lies between the arc and its chord must be added to or subtracted from the total area. See Figure 2.
The area between the arc and the chord is

$$\left\{2\sin^{-1}(d/2r) - \sin\left(2\sin^{-1}(d/2r)\right)\right\}\frac{r^2}{2}$$

where r is the radius of curvature, and d is the length of the chord. Note that the arcsine is in radians.

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)



Find the area of the tract of land described below.

Beginning, for reference, at point 0;

Thence N 47°-34'-28" E, a distance of 309.82' to a point;

Thence S 82°-50'-13" E, a distance of 279.64' to a point;

Thence, with a curve to the left having a radius of 590', and the chord of which bears N 52°-48'-37" W, a distance of 631.72' to a point;

Thence S 0°-17'-56" W, a distance of 556.00' to the beginning point.

SOLUTION:

Input	Function	Display	Comments
	[XEQ] SIZE 005		Minimum size
	[XEQ] AREA	1. BEARING?	Prompt for bearing of side 1
47.3428			Bearings entered as dd.mmss
	[B]	N 47-34-28 E	Review bearing in NE quadrant
	[R/S]	1. DISTANCE?	Prompt for distance of side 1
309.82			Distance in feet
	[R/S]	1. RADIUS?	Prompt for radius of side 1
none (no radius)			
	[R/S]	2. BEARING?	
82.5013	[G]	S 82-50-13 E	Review bearing in SE quadrant
	[R/S]	2. DISTANCE?	
279.64	[R/S]	2. RADIUS?	
none			
	[R/S]	3. BEARING?	Prompt for bearing of chord
52.4837	[A]	N 52-48-37 W	Review bearing in NW quadrant
	[R/S]	3. DISTANCE?	Prompt for length of chord
631.72	[R/S]	3. RADIUS?	Prompt for radius of side 3
590	[R/S]	CHS FOR LEFT	Change sign if curve bears to
	[CHS]	590.	the left
	[R/S]	4. BEARING?	
0.1756	[F]	S 0-17-56 W	Review bearing in SW quadrant
556.00	[R/S]	4. RADIUS?	Bypassing the prompt for distance
none			
	[R/S]	5. BEARING?	
none (no more sides)			
	[R/S]	CLOSURE 4.E-4 FT.	Closure error is 4×10^{-4} feet
	[X≷Y] (optional)	-132.	-132° = S 48° W to the end point
	[R/S]	AREA (blinks)	
		146,722. SQ. FT.	
	[R/S]	3.368 ACRES	

USER INSTRUCTIONS

				SIZE: (HP-41C) 005
STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1.	Enter the program			
2.	It is advisable to draw a sketch of the tract of land, labeling the starting point and numbering the sides consecutively as shown in Program Description II			
3.	Initialize and start prompting sequence		[XEQ] AREA	1. BEARING?
4.	Enter the bearing for side #	dd.mmss		
	note: # is the number preceeding the prompted item degrees, minutes, and seconds are entered as dd.mmss			
	• If bearing is NE		[B]	N dd-mm-ss E
	• If bearing is SE		[G]	S dd-mm-ss E
	• If bearing is SW		[F]	S dd-mm-ss W
	• If bearing is NW		[A]	N dd-mm-ss W
	or			
	If there are no more sides, go to step 9			
5.	Review bearing: if incorrect return to step 4			
	If ok go to step 6, or optionally →		[R/S]	#. DISTANCE?
6.	Enter distance, in feet, for side #	distance	[R/S]	#. RADIUS?
7.	If side is curved, enter radius, in feet	radius	[R/S]	CHS FOR LEFT
	If curve bears to the left		[CHS]	-radius
	or if side is straight proceed with step 8			
8.	Prompt for next side		[R/S]	#. BEARING?
	Go to step 4			
9.	Display closure error in feet		[R/S]	CLOSURE x FT.
	optional: Display azimuth to last point		[X≠Y]	ddd. (degrees)
10.	Display area in square feet		[R/S]	area. SQ. FT.
11.	Display area in acres		[R/S]	area. ACRES
	Note: a side may be restarted at any			
	time until the next side is requested		[E]	#. BEARING?

PROGRAM LISTING

☐ 67 ☐ 97 ☒ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
	01♦LBL "ARE A"		
	02 DEG		initialization
	03 SF 27		
	04 1.4		
	05 STO 00		
	06 CLX		
	07 STO 01		
	08 STO 02		
	09 STO 03		
	10♦LBL E		
	11 FIX 0		
	12 CF 22		
	13 CLA		
	14 ARCL 00		
	15 AVIEW		
	16 "⊢ BEARI NG?"		
	17 PROMPT		
	18 FC? 22		no entry is signal to display result
	19 GTO 05		
	20 "KEY A,B ,F,G"		message is displayed if bearing entry is followed by [R/S]
	21 TONE 0		
	22 PROMPT		
	23♦LBL A		NW bearing
	24 SF 14		
	25♦LBL B		NE bearing
	26 CF 15		
	27 "N "		
	28 GTO 02		
	29♦LBL F		SW bearing
	30 SF 14		
	31♦LBL G		SE bearing
	32 SF 15		
	33 "S "		
	34♦LBL 02		Format the display of the bearing
	35 CF 29		
	36 9		
	37 RCL Y		
	38 INT		
	39 ARCL X		
	40♦LBL 03		
	41 "⊢-"		
	42 CLX		
	43 LASTX		
	44 FRC		
	45 100		Review Bearing
	46 *		
	47 INT		
	48 X<=Y?		
	49 "⊢0"		
	50 ARCL X		
	51 FS?C 22		
	52 GTO 03		
	53 RCL Z		
	54 SF 29		
	55 FS? 14		
	56 "⊢ W"		
	57 FC? 14		
	58 "⊢ E"		
	59 HR		
	60 FS?C 14		
	61 CHS		
	62 AVIEW		
	63 STOP		
	64 CLA		
	65 ARCL 00		
	66 "⊢ DISTA NCE?"		
	67 FC? 22		Prompt for distance if not entered
	68 PROMPT		
	69 CLA		
	70 ARCL 00		
	71 FIX 2		
	72 VIEW X		
	73 STO 04		
	74 P-R		
	75 FS?C 15		change sign if south
	76 CHS		
	77 RCL 02		old y
	78 ST+ Z		
	79 RCL 03		old x
	80 ST+ Z		
	81 R↑		
	82 STO 02		New y
	83 *		
	84 R↑		
	85 STO 03		New x
	86 RCL Z		
	87 *		
	88 -		
	89 CF 22		
	90 "⊢ RADIU S?"		

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook. Refer to Appendix E in 67 or 97 "OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for exact keystrokes.

PROGRAM LISTING

☐ 67 ☐ 97 ☒ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
91	PROMPT		
92	FC?C 22		if no radius was entered, skip to step 113
93	GTO 04		
94	X↑2		
95	RCL 04		
96	LASTX		
97	"CHS FOR LEFT"		prompt for curve to left
98	TONE 5		
99	PROMPT		
100	VIEW X		
101	/		
102	2		
103	/		
104	ASIN		
105	2		
106	*		
107	D-R		
108	LASTX		
109	SIN		
110	-		
111	*		
112	+		add area under arc
113	*LBL 04		
114	ST+ 01		accumulate area
115	ISG 00		
116	GTO E		Go to next side
117	*LBL 05		
118	CF 27		
119	"CLOSURE "		
120	RCL 02		calculate closure error
121	RCL 03		
122	R-P		
123	FIX 0		
124	ARCL X		
125	"⊢ FT."		
126	AVIEW		
127	STOP		display closure error
128	ADV		
129	" ARE A"		
130	AVIEW		
131	RCL 01		calculate area
132	ABS		
133	2		
134	/		
135	CLA		
136	ARCL X		
137	"⊢ SQ. FT."		
138	AVIEW		
139	STOP		display area (ft^2)
140	43560		
141	/		
142	FIX 3		
143	CLA		
144	ARCL X		
145	"⊢ ACRES "		
146	AVIEW		display area (acres)
147	END		

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REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00	side indicator		
1	area		
2	y coordinate		
3	x coordinate		
4	used		

STATUS

SIZE 005 TOT. REG. 51 USER MODE

ENG ____ FIX ____ SCI ____ ON ____ OFF ____

DEG ____ RAD ____ GRAD ____

FLAGS

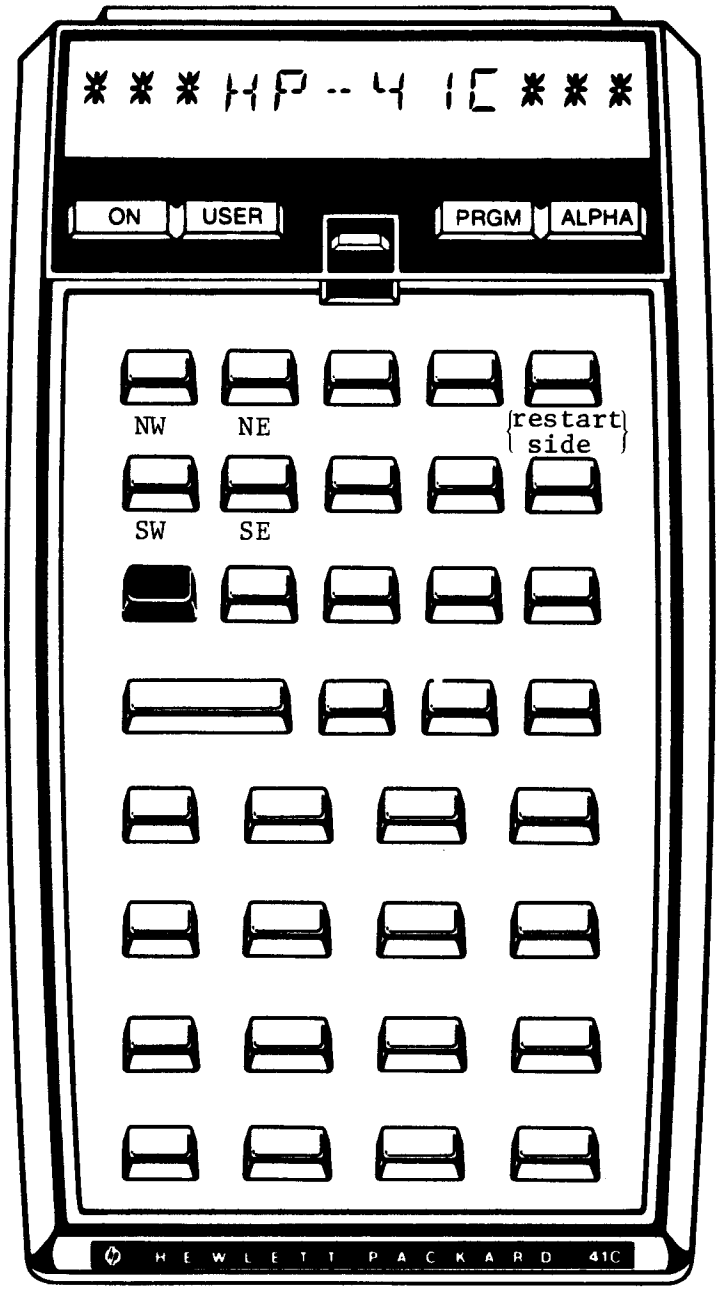
#	INIT S/C	SET INDICATES	CLEAR INDICATES
14	-	South bearing	North bearing
15	C	West bearing	East bearing
22	-	Digit entered	No digit entered
27	-	User mode on	User mode off
29	-	Dec. pt. display	Dec. pt. suppress
21		Assumed to match	printer flag 55

ASSIGNMENTS

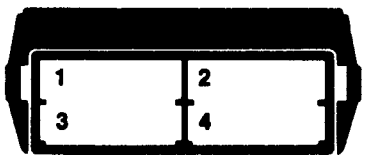
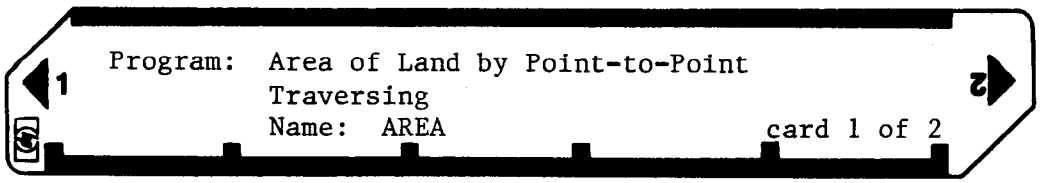
FUNCTION	KEY	FUNCTION	KEY

KEYBOARD CARD LABELING

KEYBOARD



SYSTEM CONFIGURATION



CARD