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UNITED STATES DEPARTMENT OF INTERIOR  
GEOLOGICAL SURVEY

Texas Instruments Model 59 Hand-Calculator Program  
to Calculate Magnetic Anomaly over 2-D Prisms of up to 12 Vertices

By

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Citation of particular manufacturers and model numbers does not  
constitute endorsement by the U.S. Geological Survey.

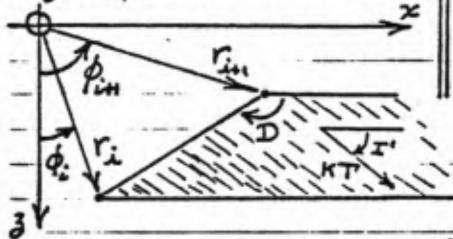
Although this program has been extensively tested, the U.S.  
Geological Survey cannot guarantee that it will give correct  
results in any or all particular applications.



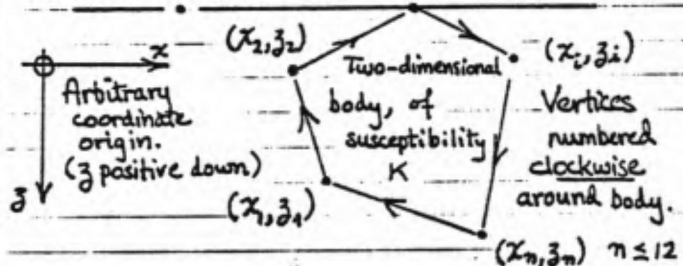
PROGRAM DESCRIPTION

Program Description, Equations, Variables, etc. A Talwani-type program to calculate  $\Delta T'$ ,  $\Delta H'$ , or  $\Delta V'$  magnetic anomaly due to 2-dimensional prism of  $n \leq 12$  vertices.

Equations: Field is superposition of fields due to  $n$  angle-edged horizontal plates like the one below:



FIELD POINT  $(X, Z)$



$$\Delta T' = 2KT h^2 \sin D [\sin(2I-D) \Delta \phi + \cos(2I-D) \Delta \ln R]$$

$$\Delta H' = 2KT h \sin D [\sin(I-D) \Delta \phi + \cos(I-D) \Delta \ln R]$$

$$\Delta V' = \text{same as } \Delta H', \text{ with } I' \leftarrow I' + \frac{\pi}{2}$$

$$h^2 = 1 - \cos^2 I \cos^2 \lambda \quad I' = \tan^{-1} \left( \frac{\tan I}{\sin \lambda} \right)$$

$$\Delta \phi = \phi_{i+1} - \phi_i \quad \Delta \ln R = \ln r_{i+1} - \ln r_i$$

$I$  = field inclination;  $\lambda$  = angle, strike to mag N.

Unprimed coordinates represent earth's true field;  
Primed coordinates are projected into x-z plane.

Reference: Hiertzler, J.R., Peter, G., Talwani, M., and Zurlueh, E.G., 1962, Lamont Geol. Obs. (Columbia Univ.) Tech. Rept. #6, CU-6-62 (Note I've changed some notation in obvious ways.)

Operating Limits and Warnings GENERAL: Equations used assume body has negligible remanent magnetization, negligible demagnetization effect, and that  $\Delta T' \ll T$ . This last condition is usually met if susceptibility  $K \ll 1$ .

USER DEFINED KEYS	DATA REGISTERS (INV INT)	LABELS (Op 08)
A $K \cdot T$	0 Index $n$	30 $\Delta X$
B $I$	1 Loop index $i$	31 $2I-D$ or $I-D$
C $\lambda$	2 $K \cdot T$	32 $\Sigma \Delta F_i'$
D Body vertex $x, z$	3 $I$	33 $R_{in}/R_i$
E Field point $x, z$	4 $\lambda$	34 $\Delta \phi_i$
A' —	5-28 ↑	35 $D_i$
B' —	≡	36 $h^2$
C' —	≡ Body vertices	37 $I'$
D' Body index $i$	≡	38 $X$
E' $\Delta X$	≡	39 $Z$
FLAGS — 0 — 1	$\Delta V'$ Field <sup>2</sup> — 3 — 4 — 5	6 7 8 9

**USER INSTRUCTIONS**

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
1	Read in both sides of Card 1. To do this: (a) Turn calculator on. If it is already on, turn it off, and then back on to clear possibly troublesome display formats. (b) Set partitioning, like this: (c) Enter "0." and feed in Side 1 of Card 1. Display will show "1." (d) Enter "0." and feed in Side 2 of Card 1. Display will show "3." If display blinks, something failed, so repeat the step.	4	2nd Op 17	639.39
2	Read in the proper side of Card 2: (a) To calculate $\Delta T'$ , enter "0." and feed in Side 1. Display will show "2." (b) To calculate either $\Delta H'$ or $\Delta V'$ , enter "0." and feed in Side 2. Display will show "2."			
3	If $\Delta V'$ is to be calculated, press ● Flag 2 must be cleared to calculate either $\Delta T'$ or $\Delta H'$ . To clear Flag 2, press	Inv	2nd St flg 2	
4	Enter field parameters (in any order) (a) Susceptibility x field strength (b) Field inclination (c) Angle, mag N to strike	KT I(deg) $\lambda$ (deg)	A B C	
5	Input body vertices (a) Initialize (b) Enter successive body vertices working clockwise around body. ● Up to 12 vertices may be entered. Flashing "12." in display after this step means you tried to enter too many. Note vertex #1 is not repeated to close the body, as in some programs.	(k=) 1 $x_1$ $z_1$	2nd D x <sup>↑</sup> t D	0 1
6	(Optional) To calculate points on a profile (Z constant)	$\Delta X$	2nd E	$\Delta X$
7	Enter field points ● Repeat step for other field points, as desired, or press R/S for next incremented X. ● Flashing "2." means flag 2 is set during an attempt to calculate $\Delta T$ .	X Z	x <sup>↑</sup> t E	$\Delta g$ mgals $\Delta T$ .

PROGRAMMER \_\_\_\_\_ DATE \_\_\_\_\_

Partitioning (Op 17) [ ] Library Module \_\_\_\_\_ Printer \_\_\_\_\_ Cards \_\_\_\_\_

USER INSTRUCTIONS

STEP	PROCEDURE	ENTER	PRESS	DISPLAY
8	To change body vertex k	k	2nd D	n-1
		$x_k$	$x \div t$	
		$z_k$	D	n=total no. of body points
	<ul style="list-style-type: none"> <li>● Body vertex k (only) is changed via step 8. However, body vertex #1 may not be changed this way, for program then thinks it is at step 5a, and that a new body is being initiated. In this case, <u>all</u> body points must be re-entered.</li> <li>● Body may be <u>extended</u> at any time via step 5b. This adds new body points, starting from previous nth body point.</li> <li>● Steps 2 through 8 may be performed in various sequences, including between field calculations, to see the effect of changing one such parameter.</li> </ul>			
9	To start a new body, clear		2nd CMS	and go to step 4.

CARD LAYOUT

1					3
MAGNETICS: 2-D Anomaly - Card 1 - 4 Op 17					
			Bod. index	$\Delta X$	
KT	I	$\lambda$	$x, z$	$X, Z$	

2		2
MAGNETICS: 2-D Anomaly - Card 2 - 4 Op 17		
← Read this side for	$\Delta T'$	
Read this side for	$\Delta H', \Delta Y'$	→

## Comments

1. This program calculates magnetic fields due to only one body at a time. Still, multi-body models may be treated by using the program to calculate magnetic anomaly for each body separately, and then manually adding component fields at the desired field points.

WARNING: This procedure gives an adequate approximation only when each component body separately satisfies the conditions listed on page 1-- no remanent magnetization, very small magnetic susceptibility, negligible demagnetization effect, and small (vector) anomalous field compared with (vector) magnetizing field.

2. This program is appropriate for simple or in-the-field applications. However, it is quite slow, taking approximately 20 seconds per body vertex for each field point calculation. Therefore, even moderately complicated bodies will take several minutes calculating time per field point. (Plan something else to do during the waiting intervals!) Clearly, complex or multi-body problems are better handled on a more time-efficient computer system.

3. Indeterminate answers (flashing "9.9999999 99") may result (i) when input field points lie on a body vertex, and (ii) when field points lie on an extension of a body side. Treat such cases by recalculating the field at nearby field points which have been migrated a small distance away from the objectionable location.

4. When using the profile option (step 6), the program will pause right after R/S is pressed (step 7) with the incremented X value in display. This feature is for the convenience of users who have no print cradle. The current field point can also be recovered--after the  $\Delta F'$  calculation has run to completion--by pressing "RCL 38" (display shows X) and "RCL 39" (display shows Z).

5. The X-profile option easily may be modified to a Z-profile option (for example, for drill hole calculations) by making the following changes on Card 2:

a. Change "SUM 38" (in addresses 457 and 458 on Side 1 and addresses 463 and 464 on Side 2) to "SUM 39".

b. Insert "Pause" after address 464 on Side 1 and after address 470 on Side 2.

c. Delete "Pause" command at address 461 on Side 1 and at address 467 on Side 2.

At instruction step 6,  $\Delta Z$  is then entered in place of the current  $\Delta X$ .

TITLE Side 1 of Card 1-1 PAGE 5 OF 12

PROGRAMMER (Magnetics: 2-D) DATE \_\_\_\_\_

TI Programmable  
Coding Form 

LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS
000	76	LBL	<u>Fcn A:</u>	055	02	2		110	69	OP	
001	11	A		056	04	4	Print	111	05	05	
002	42	STO		057	03	3		112	43	RCL	
003	02	02	Store KT	058	01	1	"FIELD	113	04	04	
004	69	OP		059	01	1	INCLIN."	114	99	PRT	Print λ
005	00	00		060	05	5		115	91	R/S	
006	02	2		061	69	OP		116	76	LBL	<u>Fcn D:</u>
007	06	6		062	02	02		117	19	D'	
008	00	0		063	02	2		118	32	X:T	
009	00	0		064	07	7		119	01	1	If i=1,
010	05	5		065	02	2		120	22	INV	zero the
011	00	0		066	04	4		121	67	EQ	body pt
012	00	0		067	03	3		122	89	↑	counter.
013	00	0	Print	068	01	1		123	42	STO	
014	69	OP		069	04	4		124	01	01	
015	01	01	"K × FIELD"	070	00	0		125	76	LBL	
016	02	2		071	00	0		126	89	↑	
017	01	1		072	00	0		127	32	X:T	
018	02	2		073	69	OP		128	65	x	
019	04	4		074	03	03		129	02	2	Convert
020	01	1		075	69	OP		130	85	+	body pt index
021	07	7		076	05	05		131	02	2	i to
022	02	2		077	43	RCL		132	95	=	storage index
023	07	7		078	03	03		133	42	STO	j.
024	01	1		079	99	PRT	Print I	134	00	00	
025	06	6		080	25	CLR		135	69	OP	Decrement
026	69	OP		081	91	R/S		136	31	31	body pt counter.
027	02	02		082	76	LBL	<u>Fcn C:</u>	137	76	LBL	
028	69	OP		083	13	↑		138	91	R/S	R/S: Display
029	05	05		084	42	STO		139	43	RCL	xi-1 or i.
030	43	RCL		085	04	04	Store λ	140	01	01	
031	02	02		086	69	OP		141	98	ADV	
032	99	PRT	Print KT	087	00	00		142	91	R/S	
033	25	CLR		088	03	3		143	76	LBL	<u>Fcn D:</u>
034	91	R/S		089	06	6		144	14	D	
035	76	LBL	<u>Fcn B:</u>	090	03	3		145	71	SBR	Temp. store
036	12	B		091	07	7		146	45	YX	xi, zi.
037	42	STO		092	03	3		147	43	RCL	
038	03	03	Store I	093	05	5		148	00	00	
039	69	OP		094	02	2		149	55	+	
040	00	00		095	04	4	Print	150	02	2	
041	02	2		096	69	OP	"STRIKE"	151	75	-	
042	01	1		097	01	01		152	01	1	Calculate
043	02	2		098	02	2		153	95	=	i from j.
044	04	4		099	06	6		154	32	X:T	
045	01	1		100	01	1		155	01	1	
046	07	7		101	07	7		156	03	3	Check for
047	02	2		102	00	0		157	32	X:T	too many
048	07	7		103	00	0		158	77	GE	body pts!
049	69	OP		104	00	0		159	77	GE	
050	01	01		105	00	0					
051	01	1		106	00	0					
052	06	6		107	00	0					
053	00	0		108	69	OP					
054	00	0		109	02	02					

MEMBER CODES  
 62 [OP] [M] 72 [STO] [M] 83 [STO] [M]  
 63 [STO] [M] 73 [RCL] [M] 84 [RCL] [M]  
 64 [RCL] [M] 74 [SUM] [M] 92 [INV] [M]

TEXAS INSTRUMENTS  
INCORPORATED

PROGRAMMER MAGNETICS : 2 D

DATE \_\_\_\_\_

LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS	
160	71	SBR	<i>Get TI print code for i.</i>	215	45	YX						
161	80	GRD			216	32	XIT	<i>Subr. for temp. storage of X, Z pairs.</i>				
162	85	+			217	42	STO					
163	01	1			218	38	38					
164	95	=			219	32	XIT					
165	69	OP			220	42	STO					
166	03	03			221	39	39					
167	01	1			222	69	OP					
168	04	4			223	00	00					
169	03	3			224	92	RTN					
170	02	2		225	76	LBL	<u>Deg:</u>					
171	01	1		226	60	DEG						
172	06	6		227	01	1	<i>TI print code for "9"</i>					
173	04	4		228	01	1						
174	05	5		229	92	RTN						
175	69	OP	<i>Print "BODY PT. i"</i>	230	76	LBL	<u>Rad:</u>					
176	01	01			231	70	RAD					
177	03	3			232	85	+	<i>TI print code for 10, 11, 12</i>				
178	03	3			233	01	1					
179	03	3			234	09	9					
180	07	7			235	00	0					
181	04	4			236	95	=					
182	00	0			237	92	RTN					
183	69	OP			238	00	0					
184	02	02			239	00	0					
185	69	OP										
186	05	05										
187	69	OP	<i>Print x,z</i>									
188	21	21										
189	43	RCL										
190	38	38										
191	99	PRT	<i>and</i>									
192	69	OP										
193	20	20										
194	72	ST*										
195	00	00	<i>Store x,z</i>									
196	69	OP										
197	20	20										
198	43	RCL										
199	39	39										
200	99	PRT										
201	72	ST*										
202	00	00										
203	61	GTO										
204	91	R/S										
205	76	LBL	<u>GE:</u>									
206	77	GE										
207	01	1	<i>Display flashing "12." for ≥ 12 input bodpts.</i>									
208	04	4										
209	04	4										
210	94	+/-										
211	34	FX										
212	95	=										
213	91	R/S										
214	76	LBL		<u>YX:</u>								

MERGED CODES

62	70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	00	01



LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS		
480	76	LBL	<i>For E'</i>	535	30	TAN		590	00	00			
481	10	E'		536	55	+		591	54	)	<i>Subroutine to calculate angle Di</i>		
482	42	STO	<i>Store ΔX</i>	537	43	RCL	<i>Calculate</i>	592	53	(			
483	30	30		538	04	04		593	32	XIT			
484	91	R/S		539	38	SIN	<i>I'</i>	594	69	OP			
485	76	LBL	<i>For E:</i>	540	95	=		595	20	20			
486	15	E		541	22	INV		596	85	+			
487	71	SBR	<i>Temp. store fieldpt X,Z</i>	542	30	TAN		597	73	RC*			
488	45	YX		543	42	STO		598	00	00			
489	60	DEG		544	37	37		599	54	)			
490	25	CLR		545	22	INV	<i>If flag 2 is set, (ΔV' field) replace I' with I'+90°</i>	600	22	INV			
491	42	STO	<i>Zero ΔV' register.</i>	546	87	IFF			601	37	P/R		
492	32	32		547	02	02			602	42	STO		
493	02	2		548	49	PRD			603	35	35		
494	01	1		549	09	9			604	03	3		
495	02	2		550	00	0		605	22	INV			
496	04	4		551	44	SUM		606	44	SUM			
497	01	1		552	37	37		607	00	00			
498	07	7		553	76	LBL		608	29	CP			
499	02	2		554	49	PRD		609	92	RTN			
500	07	7		555	43	RCL		610	76	LBL	<i>Int:</i>		
501	69	OP	<i>Print "FIELD PT."</i>	556	03	03		611	59	INT			
502	01	01			557	39	CDS		612	53	(	<i>Subroutine to restore loop register value.</i>	
503	01	1		558	33	X²		613	53	(			
504	06	6		559	65	X		614	43	RCL			
505	00	0		560	43	RCL	<i>Calculate h²</i>	615	00	00			
506	00	0		561	04	04		616	75	-			
507	03	3		562	39	CDS		617	04	4			
508	03	3		563	33	X²		618	54	)			
509	33	3		564	94	+/-		619	55	+			
510	07	7		565	85	+		620	02	2			
511	04	4		566	01	1		621	54	)			
512	00	0		567	95	=		622	42	STO			
513	69	OP		568	42	STO		623	01	01			
514	02	02		569	36	36		624	92	RTN			
515	69	OP		570	61	GTO	<i>Go to 240 (Card 2 subroutine)</i>	625	76	LBL	<i>Grd:</i>		
516	05	05		571	02	02		626	80	GRD	<i>Find TI print code for bodpt index i.</i>		
517	43	RCL		572	40	40		627	32	XIT			
518	38	38	<i>Print X Z</i>	573	76	LBL	<i>P/R:</i>	628	09	9			
519	99	PRT			574	37	P/R		629	32		XIT	
520	43	RCL		575	73	RC*		630	67	EQ			
521	39	39		576	00	00		631	60	DEG			
522	99	PRT		577	94	+/-		632	77	GE			
523	01	1		578	32	XIT		633	70	RAD			
524	03	3		579	69	OP		634	92	RTN			
525	03	3	<i>Store "ANOM" in print register.</i>	580	20	20		635	00	0			
526	01	1			581	73	RC*		636	00	0		
527	03	3			582	00	00		637	00	0		
528	02	2			583	94	+/-		638	00	0		
529	03	3			584	53	(		639	00	0		
530	00	0		585	32	XIT		MEMBER CODES					
531	69	OP		586	69	OP		62	IN	72	STO	83	GTO
532	02	02		587	20	20		63	INT	73	RCL	84	IN
533	43	RCL		588	85	+		64	PR	74	SUM	92	INW
534	03	03		589	73	RC*		TEXAS INSTRUMENTS INCORPORATED					

PROGRAMMER MAGNETICS: 2-D

DATE \_\_\_\_\_

LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS
240	22	INV	Start calc.	295	01	1		350	32	X:T	
241	87	IFF	for $\Delta T'$ :	296	32	X:T	Test if	351	69	OP	
242	02	02		297	43	RCL	$i+1$ vertex	352	20	20	
243	79	X	Display	298	01	01	equals	353	73	RC*	
244	04	4	flashing 2.	299	22	INV	1 <sup>st</sup> vertex	354	00	00	
245	94	+/-	if flag 2	300	67	EQ		355	61	GTO	
246	34	FX	is set.	301	28	LOG		356	69	OP	
247	91	R/S		302	43	RCL		357	76	LBL	<u>X<sub>1</sub>T:</u>
248	76	LBL		303	05	05	If so,	358	32	X:T	
249	79	X	<u>X:</u>	304	75	-		359	43	RCL	If so, use
250	03	3		305	73	RC*	Get $D_i$	360	05	05	$X_1, Z_1$ as
251	07	7		306	00	00	using	361	32	X:T	$i+1$ <sup>st</sup>
252	03	3	Store	307	95	=	1 <sup>st</sup> vertex	362	43	RCL	vertex.
253	02	2	"TOT."	308	32	X:T	as $i+1$ <sup>st</sup>	363	06	06	
254	03	3	in print	309	69	OP	vertex...	364	76	LBL	<u>Op:</u>
255	07	7	register.	310	20	20		365	69	OP	
256	04	4		311	43	RCL		366	22	INV	
257	00	0		312	06	06		367	37	P/R	Get
258	69	OP		313	75	-		368	22	INV	$\Delta \phi_i$ ,
259	01	01		314	73	RC*		369	44	SUM	$R_{in}/R_i$
260	69	OP		315	00	00		370	34	34	
261	05	05		316	95	=		371	32	X:T	
262	69	OP		317	22	INV		372	49	PRD	
263	00	00		318	37	P/R		373	33	33	
264	04	4	Initialize	319	42	STO		374	69	OP	
265	42	STO	index $j$ .	320	35	35		375	30	30	
266	00	00		321	69	OP		376	53	(	
267	76	LBL	<u>Sum:</u>	322	30	30		377	53	(	
268	44	SUM		323	76	LBL	<u>Log:</u>	378	02	2	Get
269	69	OP		324	28	LOG		379	65	X	$2I'-D_i$
270	20	20		325	73	RC*		380	43	RCL	
271	43	RCL		326	00	00	Recall	381	37	37	
272	38	38		327	32	X:T	coords	382	75	-	
273	94	+/-	Shift	328	69	OP	for calc.	383	43	RCL	
274	74	SM*	origin	329	20	20	of $\Delta \phi_i$ ,	384	35	35	
275	00	00	to this	330	73	RC*	$R_{in}/R_i$	385	54	)	
276	69	OP	field	331	00	00		386	42	STO	
277	20	20	point.	332	22	INV		387	31	31	
278	43	RCL		333	37	P/R		388	38	SIN	Convert
279	39	39		334	42	STO		389	65	X	$\Delta \phi_i$ to
280	94	+/-		335	34	34		390	89	π	radians &
281	74	SM*		336	32	X:T		391	55	+	mult by
282	00	00		337	35	1/X		392	01	1	$\sin(2I'-D)$
283	97	DSZ		338	42	STO		393	08	8	
284	01	01		339	33	33		394	00	0	
285	44	SUM		340	69	OP		395	65	X	
286	71	SBR	Restore	341	20	20		396	43	RCL	
287	59	INT	loop reg.	342	01	1		397	34	34	
288	05	5	Initialize	343	32	X:T	Test if $i+1$	398	85	+	
289	42	STO	index reg.	344	43	RCL	vertex equals	399	43	RCL	
290	00	00		345	01	01	1 <sup>st</sup> vertex				
291	76	LBL	<u>DSZ: Main</u>	346	67	EQ					
292	97	DSZ	loop	347	32	X:T					
293	71	SBR	entry	348	73	RC*					
294	37	P/R	Get $D_i$	349	00	00					

MERGED CODES  
 62 [IN] [MC] 72 [STO] [MC] 83 [GTO] [MC]  
 63 [LX] [MC] 73 [RCL] [MC] 84 [X] [MC]  
 64 [R] [MC] 74 [SUM] [MC] 92 [INV] [SBR]

TEXAS INSTRUMENTS  
INCORPORATED

PROGRAMMER MAGNETICS: 2-D

DATE \_\_\_\_\_

LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS
400	31	31		455	43	RCL					
401	39	COS		456	30	30	Increment				
402	65	X		457	44	SUM	$\Delta X$				
403	43	RCL		458	38	38	for profile				
404	33	33		459	43	RCL	calculations.				
405	23	LN <sub>X</sub>		460	38	38					
406	54	)		461	66	PAU					
407	65	X		462	32	XIT					
408	43	RCL	Calculate	463	43	RCL					
409	35	35	$F_i'$	464	39	39	Restart calc.				
410	38	SIN		465	61	GTO	at entry E.				
411	65	X		466	15	E					
412	43	RCL		467	00	0					
413	36	36		468	00	0					
414	65	X		469	00	0					
415	43	RCL		470	00	0					
416	02	02		471	00	0					
417	65	X		472	00	0					
418	02	2		473	00	0					
419	95	=		474	00	0					
420	94	+/-		475	00	0					
421	44	SUM		476	00	0					
422	32	32		477	00	0					
423	97	DSZ		478	00	0					
424	01	01	End of	479	00	0					
425	97	DSZ	main loop.								
426	71	SBR									
427	59	INT	Restore								
428	04	4	index								
429	42	STO	regs i, j.								
430	00	00									
431	76	LBL	$\Sigma+$ :								
432	78	$\Sigma+$									
433	69	OP									
434	20	20									
435	43	RCL									
436	38	38									
437	74	SM*	Shift								
438	00	00	origin								
439	69	OP	back to								
440	20	20	original								
441	43	RCL	position.								
442	39	39									
443	74	SM*									
444	00	00									
445	97	DSZ									
446	01	01									
447	78	$\Sigma+$									
448	71	SBR	Restore loop								
449	59	INT	reg.								
450	43	RCL									
451	32	32	Print+display								
452	99	PRT	$\Delta T'$								
453	98	ADV									
454	91	R/S									

MERGED CODES

62	73	85	72	STO	83	GTO	95
63	IC	98	73	RCL	84	→	96
64	RT	99	74	SUM	92	INV	99

TEXAS INSTRUMENTS  
INCORPORATED

LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS
240	87	IFF	Start calc	295	05	5	Initialize	350	32	X:T	
241	02	02	for $\Delta H, \Delta V$	296	42	STO	index reg.	351	43	RCL	Test if $i+1^{\text{st}}$
242	79	X		297	00	00		352	01	01	vertex
243	02	2	If flag 2	298	76	LBL	DSZ: main	353	67	EQ	equals $1^{\text{st}}$
244	03	3	set, get $\Delta V$	299	97	DSZ	loop	354	32	X:T	vertex
245	03	3		300	71	SBR	entry	355	73	RC*	
246	02	2		301	37	P/R	Get $D_i$	356	00	00	
247	03	3		302	01	1		357	32	X:T	
248	05	5	"HOR."	303	32	X:T		358	69	OP	
249	04	4		304	43	RCL	Test if $i+1^{\text{st}}$	359	20	20	
250	00	0		305	01	01	vertex equals	360	73	RC*	
251	61	GTO		306	22	INV	$1^{\text{st}}$ vertex	361	00	00	
252	22	INV		307	67	EQ		362	61	GTO	
253	76	LBL		308	28	LOG		363	69	OP	
254	79	X		309	43	RCL		364	76	LBL	X+T:
255	04	4		310	05	05	If so,	365	32	X:T	
256	02	2		311	75	-		366	43	RCL	If so, use
257	01	1	"VER."	312	73	RC*	Get $D_i$	367	05	05	$X_1, Z_1$ as
258	07	7		313	00	00	using	368	32	X:T	$i+1^{\text{st}}$ vertex.
259	03	3		314	95	=	$1^{\text{st}}$ vertex	369	43	RCL	
260	05	5		315	32	X:T	as $i+1^{\text{st}}$	370	06	06	
261	04	4		316	69	OP	vertex	371	76	LBL	Op:
262	00	0		317	20	20		372	69	OP	
263	76	LBL	Inv:	318	43	RCL		373	22	INV	Get
264	22	INV	Print	319	06	06		374	37	P/R	$\Delta \phi_i,$
265	69	OP	" ANOM"	320	75	-		375	22	INV	$R_{in}/R_i$
266	01	01		321	73	RC*		376	44	SUM	
267	69	OP		322	00	00		377	34	34	
268	05	05		323	95	=		378	32	X:T	
269	69	OP		324	22	INV		379	49	PRD	
270	00	00		325	37	P/R		380	33	33	
271	04	4	Initialize	326	42	STO		381	69	OP	
272	42	STO	index j.	327	35	35		382	30	30	
273	00	00		328	69	OP		383	53	(	
274	76	LBL	Sum:	329	30	30		384	53	(	
275	44	SUM		330	76	LBL	Log:	385	43	RCL	Get
276	69	OP		331	28	LOG		386	37	37	$I'-D_i$
277	20	20		332	73	RC*		387	75	-	
278	43	RCL	Shift	333	00	00	Recall	388	43	RCL	
279	38	38	origin to	334	32	X:T	coords	389	35	35	
280	94	+/-	this field	335	69	OP	for calc.	390	54	)	
281	74	SM*	point.	336	20	20	of	391	42	STO	
282	00	00		337	73	RC*		392	31	31	
283	69	OP		338	00	00	$\Delta \phi_i,$	393	38	SIN	Convert
284	20	20		339	22	INV		394	65	X	$\Delta \phi_i$ to
285	43	RCL		340	37	P/R	$R_{in}/R_i$	395	89	11	radians
286	39	39		341	42	STO		396	55	+	+ mult. by
287	94	+/-		342	34	34		397	01	1	$\sin(I-D)$
288	74	SM*		343	32	X:T		398	08	8	
289	00	00		344	35	1/X		399	00	0	
290	97	DSZ		345	42	STO					
291	01	01		346	33	33					
292	44	SUM		347	69	OP					
293	71	SBR	Restore	348	20	20					
294	59	INT	loop reg.	349	01	1					

MERGED CODES

62	INT	63	INT	72	STO	83	GTO
63	INT	73	RCL	84	X		
64	INT	74	SUM	92	INV	SBR	

PROGRAMMER MAGNETICS: 2-D DATE \_\_\_\_\_

LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS
400	65	X		455	59	INT	Restore loop				
401	43	RCL		456	43	RCL	reg.				
402	34	34		457	32	32					
403	85	+		458	99	PRT	Print & display				
404	43	RCL		459	98	ADV	AF'				
405	31	31		460	91	R/S					
406	39	CDS		461	43	RCL					
407	65	X		462	30	30	Increment by				
408	43	RCL	Get	463	44	SUM	$\Delta X$ for				
409	33	33	$F_i$	464	38	38	profile				
410	23	LNX		465	43	RCL	calculation.				
411	54	)		466	38	38					
412	65	X		467	66	PAU					
413	43	RCL		468	32	XIT					
414	35	35		469	43	RCL					
415	38	SIN		470	39	39	Restart calc.				
416	65	X		471	61	GTO	at entry E.				
417	43	RCL		472	15	E					
418	36	36		473	00	0					
419	34	FX		474	00	0					
420	65	X		475	00	0					
421	43	RCL		476	00	0					
422	02	02		477	00	0					
423	65	X		478	00	0					
424	02	2		479	00	0					
425	95	=									
426	94	+/-									
427	44	SUM									
428	32	32									
429	97	DSZ	End of								
430	01	01	Main								
431	97	DSZ	Loop -								
432	71	SBR	Restore								
433	59	INT	index regs								
434	04	4	i, j								
435	42	STD									
436	00	00									
437	76	LBL	$\Sigma+$ :								
438	78	$\Sigma+$									
439	69	OP									
440	20	20									
441	43	RCL	Shift								
442	38	38	origin								
443	74	SM*	back								
444	00	00	to								
445	69	OP	initial								
446	20	20	position.								
447	43	RCL									
448	39	39									
449	74	SM*									
450	00	00									
451	97	DSZ									
452	01	01									
453	78	$\Sigma+$									
454	71	SBR									

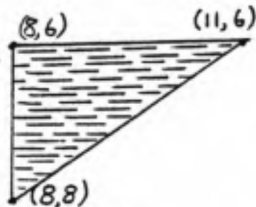
MERGED CODES

62	FIN	INT	72	STO	INT	83	GTO	INT
63	LOC	INT	73	RCL	INT	84	DS	INT
64	PR	INT	74	SUM	INT	92	INV	SBR

TEXAS INSTRUMENTS  
INCORPORATED

Example:

Find  $\Delta T'$ ,  $\Delta H'$ , and  $\Delta V'$  at field points  $(X, Z) = (5, 5)$  and  $(8, 5)$  due to 2-D triangular body shown. Take  $T = 50,000 \text{ nT}$ ,  $\kappa = 0.001 \text{ emu}$  (i.e.,  $\kappa T = 50 \text{ nT}$ ),  $I = 10^\circ$ , and  $\lambda = 60^\circ$ .



SOLUTION:

variable	Key	display
$\kappa T$	50. A	0.
$I$	10. B	0
$\lambda$	60. C	60.
$i$	1. 2 <sup>nd</sup> D	0.
$x_1$	8 $x \leftarrow t$	(1.)
$z_1$	8 D	1.
$x_2$	8 $x \leftarrow t$	(9.)
$z_2$	6 D	2.
$x_3$	11 $x \leftarrow t$	(9.)
$z_3$	6 D	3.
$X$	5 $x \leftarrow t$	(9.)
$Z$	5 E	10.93630999
$X$	8 $x \leftarrow t$	(45.)
$Z$	5 E	-12.5458537

• Read Side 2 of Card 2 for  $\Delta H'$  field.

$X$	5. $x \leftarrow t$	(90.)
$Z$	5 E	11.14224509
$X$	8 $x \leftarrow t$	(45.)
$Z$	5 E	-25.50309898

• Set Flag 2 for  $\Delta V'$  field:

	2 <sup>nd</sup> St flag 2	
$X$	5. $x \leftarrow t$	(90.)
$Z$	5 E	8.254850669
$X$	8 $x \leftarrow t$	(45.)
$Z$	5 E	53.00911886

1.  
Display values enclosed in parentheses have no particular significance, but are given here to help debug new programs.

K x FIELD	50.
FIELD INCLIN.	10.
STRIKE	60.
<hr/>	
BODY PT.	1
	8.
	8.
BODY PT.	2
	8.
	6.
BODY PT.	3
	11.
	6.
<hr/>	
FIELD PT.	5.
	5.
TOT. ANOM	10.93630999
FIELD PT.	8.
	5.
TOT. ANOM	-12.5458537
<hr/>	
FIELD PT.	5.
	5.
HOR. ANOM	11.14224509
FIELD PT.	8.
	5.
HOR. ANOM	-25.50309898
<hr/>	
FIELD PT.	5.
	5.
VER. ANOM	8.254850669
FIELD PT.	8.
	5.
VER. ANOM	53.00911886