

Program Description I

Program Title	67-GAUSSIAN ELIMINATION FOR UP TO 12 EQUATIONS AND UNKNOWN		
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Program Description, Equations, Variables THIS PROGRAM USES GAUSSIAN ELIMINATION TO SOLVE THE SYSTEM $\sum_{j=1}^N a_{ij} X_j = a_{i, N+1}$, $i=1, 2, \dots, N$ WITH $5 \leq N \leq 12$. IT CAN BE USED FOR $N \leq 5$, BUT THERE ARE BETTER PROGRAMS FOR THESE CASES.

THE PROGRAM WORKS IN 3 PHASES. PHASE I IS DATA INPUT AND STORAGE. DATA IS ENTERED ONE ROW AT A TIME. THE CALCULATOR WILL FLASH THE NUMBER OF THE ELEMENT IT WANTS AND THE OPERATOR MUST KEY IT IN DURING THE PAUSE. WHEN EACH ROW HAS BEEN ENTERED IT IS RECORDED ON A MAGNETIC CARD. THE FIRST STEP OF THE ELIMINATION PROCESS IS ALSO ACCOMPLISHED DURING THIS PHASE, SO ONLY THE FIRST CARD MATCHES THE ORIGINAL EQUATION.

PHASE II IS THE ELIMINATION PROCESS. TO START, ROW 2 IS FED IN TO ELIMINATE X_2 FROM ROWS 3 TO N. ROW 3 IS FED IN, X_2 IS ELIMINATED, THEN THE NEW ROW 3 IS RECORDED ON A DIFFERENT CARD. THIS PROCEDURE IS REPEATED FOR ROWS 4 TO N. IN SUBSEQUENT ELIMINATION STEPS, WHEN A ROW IS ALTERED, THE NEW VERSION WILL BE RECORDED OVER THE OLD, BUT IT IS VERY HELPFUL TO KEEP THE ORIGINAL INPUT AS BACKUP. THEN, IF AN ERROR IS MADE, THE

Operating Limits and Warnings PROCESSING CAN BE RESTARTED AT THE BEGINNING OF PHASE II. IF AN ERROR IS MADE AND THE ORIGINAL INPUT CARDS HAVE BEEN WRITTEN OVER, THE PROCESSING MUST BE RESTARTED AT THE BEGINNING OF PHASE I. WITH THIS BACKUP $2N-2$ MAGNETIC CARDS ARE NEEDED, WITHOUT IT ONLY N CARDS ARE NECESSARY. THE CALCULATOR WILL FLASH THE ROW NUMBERS AS THE ROWS ARE NEEDED. WHEN ROW K IS BEING USED TO ELIMINATE X_K

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~~Program Description, Equations, Variables~~ FROM i , $\phi = a_{i,k}/a_{k,k}$, AND
 $a'_{i,j} = a_{i,j} - \phi * a_{i,k}$, $j = k, k+1, \dots, N+1$.

PHASE III IS THE BACKWARD SUBSTITUTION PROCESS. THE CALCULATOR WILL FLASH THE ROW NUMBERS IN REVERSE ORDER AS NEEDED.

$$X_N = \frac{a_{N,N+1}}{a_{N,N}}$$

$$X_K = \frac{a_{K,N+1} - \sum_{j=K+1}^N a_{Kj} X_j}{a_{Kk}} \quad K = N-1, N-2, \dots, 1$$

WHEN THE PROCESSING IS COMPLETED, THE X'S CAN BE DISPLAYED REPEATEDLY WITH AS MANY SIGNIFICANT FIGURES AS DESIRED.

Operating Limits and Warnings IF THIS PROGRAM IS TO BE USED FOR $N=2$, PHASE II SHOULD BE SKIPPED. WHEN THE CALCULATOR DISPLAYS 2.1 AT THE END OF PHASE I, GO DIRECTLY TO PHASE III BY KEYING [9] [MERGE] AND LOADING CARD 2 SIDE 2.

IF ALL CHOICES FOR THE NEXT PIVOT ARE ZERO, OR IF $a_{nn} = 0$ AFTER THE LAST STEP OF PHASE II, THE SYSTEM DOES NOT HAVE A UNIQUE SOLUTION AND THE PROGRAM MUST BE TERMINATED.

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Sketch(es)

1				
2				
3				
4				
5				

FIGURE 1

1	#1		
2	#2	3.60	
3	#3	-1.80	
4	#4	1.40	
5	#5	6.80	

FIGURE 2

Sample Problem(s) SOLVE THE FOLLOWING SYSTEM OF 5 EQUATIONS IN 5 UNKNOWN

$$5X_1 - X_2 + X_3 + X_4 + 2X_5 = 4$$

$$3X_1 + 3X_2 - 2X_3 - 6X_4 + 3X_5 = -6$$

$$X_1 - 2X_2 + 4X_3 + 2X_4 - X_5 = 4$$

$$2X_1 + 3X_2 - X_3 - X_4 + 2X_5 = -2$$

$$4X_1 + 6X_2 - 5X_3 - 3X_4 + 3X_5 = 1$$

NOTICE THAT THE EQUATIONS HAVE BEEN ARRANGED SO THAT THE FIRST PIVOT ELEMENT, a_{11} , HAS THE LARGEST POSSIBLE ABSOLUTE VALUE.

ON A BLANK SHEET OF PAPER SKETCH AN ENLARGEMENT OF FIGURE 1 BIG ENOUGH THAT MAGNETIC CARDS FIT EASILY IN THE LONG BOXES. TAKE 8 MAGNETIC CARDS AND NUMBER THEM 1 TO 8. LOAD SIDES 1 AND 2 OF PROGRAM CARD 1. KEY 5 [A] → "1.00" ("X" INDICATES FLASHING PAUSE DISPLAY WAITING FOR DATA ENTRY.) 5 → "2.00"

Solution(s) 1 [CH] → "3.00" 1 → "4.00" 1 → "5.00" 2 → "6.00" 4 → [F].

RECORD CARD 1 AND PLACE IT IN THE FIRST ROW OF THE DIAGRAM →

"1.00" 3 → "2.00" 3 → "3.00" 2 [CH] → "4.00" 6 [CH] → "5.00" 3 →

"6.00" 6 [CH] → [F]. RECORD CARD 2 → 3.60 *** (***) INDICATES PRINTED OUTPUT ON HP-97 OR PAUSE DISPLAY TO BE WRITTEN DOWN ON HP-67.)

WRITE 3.60 IN THE BOX AT THE END OF ROW 2 OF THE DIAGRAM, THEN PLACE CARD 2 IN ROW 2 OF THE DIAGRAM → "1.00" 1 ETC. → [F].

RECORD CARD 3 → -1.80 ***, WRITE -1.80 IN THE FIRST OF THE 2 BOXES AT THE END OF ROW 3 AND PLACE CARD 3 IN ROW 3 → "1.00". ENTER AND

Reference(s) RECORD ROWS 4 AND 5 THE SAME WAY. WHEN THIS IS DONE, THE CALCULATOR WILL STOP WITH 2.1 SHOWING ON THE DISPLAY, AND THE DIAGRAM LOOKS LIKE FIGURE 2. THE NUMBERS 3.60, -1.80, 1.40 AND 6.80 ARE OUR CHOICES FOR THE NEXT PIVOT ELEMENT. THE PIVOT ELEMENT MAY BE ANY NON-ZERO NUMBER, BUT FOR BEST

Sketch(es)

1	#1		
2	#5	3.60	
3	#6	2.26	
4	#7	-0.21	
5	#8	0.47	

FIGURE 3

1	#1		
2	#5	3.60	
3	#6	-1.80	2.26
4	#7		-0.55
5	#8		-4.75

FIGURE 4

Sample Problem(s) RESULTS, WE SHOULD PICK THE NUMBER WITH THE LARGEST ABSOLUTE VALUE AS THE PIVOT. WE MUST THEREFORE INTERCHANGE ROWS 2 AND 5, WHICH WE ACCOMPLISH BY PUTTING CARD 5 IN ROW 2 OF THE DIAGRAM AND CARD 2 IN ROW 5.

WE ARE NOW READY FOR PHASE II. PRESS [9] [MERGE], LOAD ~~CARD 2~~ PROGRAM CARD 2 SIDE 1, AND PRESS [A] → "2.00". FEED THE CARD IN ROW 2 OF THE DIAGRAM (CARD 5) AND REPLACE IT IN THE DIAGRAM → "3.00". FEED THE CARD IN ROW 3 (CARD 3) AND SET IT ASIDE → 2.26***. WRITE 2.26 IN THE LAST BOX OF ROW 3 → [F]. RECORD CARD 6 AND PLACE IT IN ROW 3 OF THE DIAGRAM OFFSET ONE BOX TO THE RIGHT → "4.00". REPEAT THE PRECEDING PROCEDURE BY RECORDING CARD 7 FOR ROW 4 AND CARD 8 FOR ROW 5. THE DIAGRAM NOW LOOKS LIKE FIGURE 3 AND THE CALCULATOR IS FLASHING "3.00". SINCE THE CHOICE OF PIVOT WITH THE LARGEST ABSOLUTE VALUE IS ALREADY IN ROW 3, NO INTERCHANGE

Solution(s) IS NEEDED THIS TIME. FEED IN ROW 3 (CARD 6) AND REPLACE IT IN THE LONG BOX OF ROW 3 → "4.00". FEED IN ROW 4 (CARD 7) → -0.55***. WRITE -0.55 IN THE LAST BOX OF ROW 4 → [F]. RECORD CARD 7 AND PLACE IT IN ROW 4 OFFSET TWO BOXES TO THE RIGHT → "5.00". REPEAT FOR ROW 5. THE DIAGRAM NOW LOOKS LIKE FIGURE 4 AND THE CALCULATOR IS FLASHING "4.00". THE CHOICE OF PIVOT WITH THE LARGEST ABSOLUTE VALUE IS IN ROW 5, SO ROWS 4 AND 5 (CARDS 7 AND 8) MUST BE INTERCHANGED. NOW FEED IN ROW 4 (CARD 8) AND PLACE IT BACK IN THE DIAGRAM → "5.00". FEED IN ROW 5 (CARD 7) → .67***.

Reference(s) THIS VALUE NEED NOT BE WRITTEN, BUT WE MUST OBSERVE THAT IT IS NOT ZERO → [F]. RECORD CARD 7 AND PLACE IT IN THE DIAGRAM WHICH NOW LOOKS LIKE FIGURE 5 → 2.2

WE ARE NOW READY FOR PHASE III. PRESS [9] [MERGE], LOAD PROGRAM CARD 2 SIDE 2, AND PRESS [A] → "5.00". FEED IN ROW

Sketch(es)

1	#1			
2	#5	3.60		
3	#6	-1.80	2.26	
4	#8	1.40	-0.21	-0.55
5	#7	6.80	0.47	-4.75

FIGURE 5

Sample Problem(s) 5 (CARD 7) AND REPLACE IT IN THE DIAGRAM $\rightarrow$ "4.00".
CONTINUE FEEDING IN ROWS IN REVERSE ORDER UNTIL ALL HAVE
BEEN READ $\rightarrow$ 0.00.

TO PRINT OR DISPLAY ANSWERS, DECIDE ON THE DESIRED NUMBER OF
DECIMAL PLACES (SAY 4). KEY 4 [B] $\rightarrow$ 1. ***

2.0000 ***

2. ***

0.3333 ***

3. ***

-0.5000 ***

4. ***

0.8333 ***

5. ***

-3.0000 ***

0.00

Solution(s)

THE DISPLAY CAN BE REPEATED ANY NUMBER OF TIMES BY KEYING
d = NUMBER OF DECIMAL PLACES AND [B].

Reference(s)

GAUSSIAN ELIMINATION CAN BE FOUND IN ALMOST ANY
LINEAR ALGEBRA TEXT.

User Instructions

00680D

GAUSS CARD 1

1

2

N, START
IVS ?
ERROR

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	LOAD CARD 1 SIDES 1 AND 2		☐ ☐	0.00
2	(OPTIONAL) SET INPUT VALIDATION STOP, IF THIS MODE IS SET THE CALCULATOR WILL STOP AFTER EACH DATA ENTRY. IF THE NUMBER IS CORRECT PRESS R/S. IF THE NUMBER IS WRONG PRESS CLX, KEY CORRECT NUMBER, AND PRESS R/S		C ☐	1.00/0.00
3	ENTER NUMBER OF UNKNOWN'S	n	A ☐	"1.00"
4	ENTER ELEMENTS OF FIRST ROW	a_{11} : a_{1n+1}	☐ ☐	"2.00"
5	RECORD ON BLANK CARD		☐ ☐	[rd
6	ENTER ELEMENTS OF NEXT ROW	a_{k1} : a_{kn+1}	☐ ☐	"1.00"
7	RECORD ON BLANK CARD		☐ ☐	"2.00"
8	REPEAT STEPS 6 & 7 FOR ROWS 2 TO N		☐ ☐	[rd
9	ERROR ROUTINES (IVS NOT SET)		☐ ☐	$a'_{k2} ***$
	(a) IF AN ERROR IS MADE IN a_{ij} , $j < n+1$, WAIT FOR "J+1", THEN	a_{ij}	R/S E ☐	"1.00"
	CONTINUE NORMAL PROCESSING		☐ ☐	2.1
	(b) IF AN ERROR IS MADE IN $a_{i,n+1}$, WAIT FOR [rd], THEN	$a_{i,n+1}$	CLX E ☐	"J"
	CONTINUE NORMAL PROCESSING		☐ ☐	"J+1"
	(c) IF AN ERROR IN ROW 1 IS DETECTED AFTER THE OPPORTUNITY TO APPLY 9(a) OR 9(b) IS PASSED, PRESS R/S AND START OVER AT STEP 3.		☐ ☐	"N+1"
	(d) IF AN ERROR IN ROW K, $2 \leq K \leq N$, AFTER THE OPPORTUNITY TO APPLY 9(a) OR 9(b) IS PASSED, CONTINUE NORMAL PROCESSING TO 2.1. THEN	a_{k1} : a_{kn+1}	E ☐	[rd
	RECORD ON SAME CARD USED FOR ROW K IN STEP 7		☐ ☐	$a'_{k2} ***$
	CONTINUE NORMAL PROCESSING		☐ ☐	2.1

1 2
 GAUSS CARD 2
 CONTINUE N RESET ERROR

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
10	WHEN PHASE I IS COMPLETED		9 MERGE	2.1
11	LOAD CARD 2 SIDE 1			2.1
12	CONTINUE		A	"2.00"
13	FEED ROW 2			"3.00"
14	FEED THE NEXT ROW (ROW i)			$a'_{i,3} ***$
				[rd
15	RECORD ON BLANK CARD			"L+1"
16	REPEAT STEPS 14 & 15 FOR ROWS 3 TO N			"3.00"
17	FEED NEXT PIVOT ROW (ROW K)			"K+1"
18	FEED NEXT ROW (ROW i)			$a'_{i,k+1} ***$
				[rd
19	RECORD OVER PREVIOUS ROW i			"L+1"
20	REPEAT STEPS 18-19 FOR ROWS K+1 TO N			"K+1"
21	REPEAT STEPS 17-20 FOR ROWS 3 TO N-1			2.2
22	PHASE II COMPLETED		9 MERGE	2.2
23	LOAD CARD 2 SIDE 2			2.2
24	CONTINUE		A	"N"
25	FEED ROWS N, N-1, ..., 1 ON CUE			"N-1"
				:
				"1"
				0.00
26	SELECT NUMBER OF DECIMAL PLACES	d	B	1. ***
				$x_1 ***$
				:
				N ***
				$x_N ***$
27	(OPTIONAL) REPEAT STEP 26 WITH DIFFERENT VALUE OF d .			
28	ERROR ROUTINES			
	(a) IF ROW i IS MISREAD			Error
			CLY E	"i"
	REFEED ROW i AND CONTINUE NORMAL PROCESSING			
	(b) IF THE WRONG CARD IS FED		R/S	
		N	D	N-2.1
	GOTO STEP 12 IF ON SIDE 1* OR TO 24 IF ON SIDE 2.			
	* USE THE ORIGINAL ROWS 3 TO N IN STEP 14.			

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	9 LBLFC	32 25 15	READ SUBROUTINE		1	01	STEPS 48 TO 64 SET UP INDICES IN I FOR NESTED LOOPS
	H CF 3	35 61 03			+	61	
	9 MERGE	32 41			+	61	
	H PAUSE	35 72		060	H STI	35 33	
	H F? 3	35 71 03			RCL E	34 15	
	H RTN	35 22			2	02	
	GTO FC	22 31 15			+	61	
	9 LBL d	32 25 14			STO E	33 15	
010	1	01	SUBROUTINE TO PLACE PIVOT ROW IN TOP HALF OF MEMORY		F LBL 0	31 25 00	ENTER AND STORE FIRST ROW
	-	51			RCL E	34 15	
	H XZY	35 52			H RCL	35 34	
	-	51			F INT	31 83	
	H XZI	35 24			-	51	
	RCL (i)	34 24		070	FE	32 22 15	
	H XZI	35 24			H F? 0	35 71 00	
	H RA	35 54			R/S	84	
	+	61	SUBROUTINE $X \leftarrow 100X$		H XZY	35 52	MOVE 1ST ROW TO TOP HALF OF MEMORY AND RESET INDICES
	H XZI	35 24			1	01	
	STO (i)	33 24			-	51	
020	H RY	35 53			H XZI	35 24	
	H XZI	35 24			H XZY	35 52	
	F DSZ	31 33			STO (i)	33 24	
	GTO fd	22 31 14			H XZY	35 52	
	H RTN	35 22		080	H XZI	35 24	
	9 LBLFC	32 25 13	SUBROUTINE $X \leftarrow \frac{X}{100}$		F DSZ	31 33	STEPS 101 TO 165 READ ROW i, 2 ≤ i ≤ N; ELIMINATE X _i AND RECORD.
	EEX	43			GTO 0	22 00	
	2	02			F W/DATA	31 41	
	X	71			ENTER↑	41	
	H RTN	35 22			ENTER↑	41	
030	9 LBL b	32 25 12			H RCI	35 34	
	EEX	43			1	01	
	2	02			+	61	
	2	81	RESET SUBROUTINE		+	61	READ ROW i, 2 ≤ i ≤ N; ELIMINATE X _i AND RECORD.
	H RTN	35 22		090	H STI	35 33	
	F LBL D	31 25 14			H RY	35 53	
	H CF 0	35 61 00			1	01	
	ENTER	41			+	61	
	F b	32 22 12			+	61	
	H XZY	35 52			F d	32 22 14	
040	2	02	MERGE POINT FOR PROGRAMS 2.1 AND 2.2		1	01	READ ROW i, 2 ≤ i ≤ N; ELIMINATE X _i AND RECORD.
	-	51			-	51	
	+	61			H XZI	35 24	
	H STI	35 33			F d	32 22 13	
	F LBL 9	31 25 09		100	H XZI	35 24	
	DSP 1	23 01			F LBL 2	31 25 02	
	H RTN	35 22			1	01	
	F LBL A	31 25 11	← READ Q _{i1}		+	61	
	STO E	33 15			H RCI	35 34	
	F b	32 22 12			F b	32 22 12	
050	F b	32 22 12			+	61	
	RCL E	34 15			F LBL 6	31 25 06	
	1	01			H SE 2	35 51 02	
	-	51			H STI	35 33	
	F b	32 22 12		110	1	01	
	+	61			F E	32 22 15	
	RCL E	34 15			H F? 0	35 71 00	

REGISTERS									
0	1	2	3	4	5	6	7	8	9
←	→	→	→	USED	→	→	→	→	→
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
←	→	→	→	USED	→	→	→	→	→
A	B	C	D	E	F	G	H	I	J
←	→	→	USED	→	→	→	→	→	→

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
	R/S	84			2	02	
	RCL (i)	34 84		170	.	83	
	÷	81	← FIND Q		1	01	
	1	01			H SF 3	35 51 03	
	CHS	42			GTO 7	22 09	← BRANCH TO MERGE POINT
	F LBL 3	31 25 03	STEPS 118 TO 153		F LBL C	31 25 13	
	H RCL	35 34	READ a_{ij} , $2 \leq j \leq n+1$,		H F? 0	35 71 00	SET OR UNSET
120	H XZ Y	35 52	SUBTRACT qa_{ij} AND		GTO 1	22 01	IVS.
	+	61	STORE		H SF 0	35 51 00	
	H LST X	35 82			1	01	
	3	03			H RTN	35 22	
	+	61		180	F LBL 1	31 25 01	
	+	61			H CF 0	35 61 00	
	H LST X	35 82			0	00	
	H XZ Y	35 52			H RTN	35 22	
	H XZ Z	35 24			F LBL E	31 25 15	
	RCL (i)	34 24			H F? 3	35 71 03	
130	H R↑	35 54			GTO 7	22 07	
	X	71			H F? 1	35 71 01	
	H ST Z	35 33			GTO 4	22 04	
	H R↓	35 53			H F? 2	35 71 02	
	H LST X	35 82		190	GTO 5	22 05	
	H XZ Y	35 52			F ISZ	31 34	
	H R↑	35 54			GTO 0	22 00	
	FE	32 22 15	← READ a_{ij}		F LBL 5	31 25 05	
	H F? 0	35 71 00			H R↓	35 53	
	R/S	84			GTO 6	22 06	
140	H F? 2	35 71 02			F LBL 4	31 25 04	
	H SF 1	35 51 01			H F? 2	35 71 02	
	H XZ Y	35 52			GTO 8	22 08	
	H XZ Z	35 24			4	04	
	-	51		200	-	51	
	H XZ Z	35 24			H XZ Y	35 52	
	2	02			H ST Z	35 33	
	-	51			F ISZ	31 34	
	H XZ Z	35 24			H R↓	35 53	
	STO (i)	33 24			GTO 3	22 03	
150	H R↓	35 53			F LBL 8	31 25 08	
	H XZ Z	35 24			1	01	
	F DSZ	31 33			-	51	
	GTO 3	22 03			F ISZ	31 34	
	H SF 2	35 51 02		210	GTO 3	22 03	
	F WDATA	31 41			F LBL 7	31 25 07	
	RCL 0	34 00			OSP 2	23 02	
	F -X-	31 84			H RCL	35 34	
	H R↓	35 53			9 FRAC	32 83	
	H XZ Z	35 24			H XZ Z	35 24	
160	F C	32 22 13			F ISZ	31 34	
	H XZ Z	35 24			F INT	31 83	
	H CF 1	35 61 01			1	01	
	H CF 2	35 61 02			+	61	
	F OSZ	31 33		220	GTO 2	22 02	
	GTO 2	22 02					
	H RCL	35 34	STEPS 166-173				
	F C	32 22 13	SET UP FOR				
	D	31 22 14	PROGRAM 2.1				

ERROR ROUTINES
TO RESET
INDEXES AND
BRANCH BACK
TO APPROPRIATE
POINT IN
MAIN
PROGRAM

LABELS				FLAGS		SET STATUS		
A	B	C	D	E	F	FLAGS	TRIG	DISP
N START		IVS ?		ERROR	IVS	ON OFF		
8	÷ 100	X 100	MOVE UP PIVOT ROW	READ	1 USED	0 ☐ ☒	DEG ☒	FIX ☒
0	←	2 USED	3	→	2 USED	1 ☐ ☒	GRAD ☐	SCI ☐
5	←	7 USED	8	→	3 USED	2 ☐ ☒	RAD ☐	ENG ☐
						3 ☐ ☒		n 2

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	H SPACE	35 84	SET UP INDEXES		H RCI	35 34	← Q IS DEFINED
	OSP 2	23 02			+	61	
	H RCI	35 34			f ISZ	31 34	
	1	01		060	RCL 0	34 00	
	+	61			RCL (I)	34 24	
	H XZ I	35 24			÷	81	
	ENTER ↑	41			H XZ Y	35 52	
	9 FRAC	32 83			H XZ I	35 24	
	f C	32 22 13			H XZ Y	35 52	
010	H XZ Y	35 52			1	01	
	f INT	31 83	← READ PIVOT ROW MOVE PIVOT ROW TO TOP HALF OF MEMORY		CHS	42	
	-	51			f LBL 1	31 25 01	
	f LBL E	31 25 15			2	02	
	H F? O	35 71 00		070	+	61	
	GTO E	22 15			H XZ Y	35 52	
	f C	32 22 15			H R↑	35 54	
	H LST X	35 82			H XZ I	35 24	
	f ISZ	31 34			f ISZ	31 34	
	2	02			H XZ Y	35 52	
020	+	61			RCL (I)	34 24	
	ENTER ↑	41	SET UP INDEXES		H XZ Y	35 52	
	ENTER ↑	41			X	71	
	ENTER ↑	41			H R↑	35 54	
	H RCI	35 34		080	H XZ I	35 24	
	+	61			H XZ Y	35 52	
	f d	32 22 14			STO - U)	33 51 24	
	2	02			H R↓	35 53	
	-	51			H XZ Y	35 52	
	f INT	31 83			H LST X	35 82	
030	H LST X	35 82			H XZ Y	35 52	
	+	61	STEPS 36 TO 102 READ ROWS BELOW PIVOT, ELIMINATE NEXT X, AND RECORD NEW VALUES OF THE ROW.		RCL (I)	34 24	
	f b	32 22 12			f OSZ	31 33	
	+	61			GTO 8	22 08	
	H ST I	35 53		090	f -X-	31 84	
	H SFO	35 51 00			f LBL 8	31 25 08	
	f LBL 4	31 25 04			STO (I)	33 24	
	H RCI	35 34			H R↓	35 53	
	9 FRAC	32 83			H XZ I	35 24	
	f C	32 22 13			f OSZ	31 33	
	f INT	31 83			GTO 1	22 01	
040	H LST X	35 82	← READ NEXT ROW		f W/DATA	31 41	
	9 FRAC	32 83			H RCI	35 34	
	+	61			f C	32 22 13	
	H RCI	35 34		100	H ST I	35 33	
	f INT	31 83			f OSZ	31 33	
	-	51			GTO 4	22 04	
	1	01			H CPO	35 61 00	
	+	61			H RCI	35 34	
	H XZ Y	35 52			f C	32 22 13	
	1	01			H ST I	35 33	
050	+	61	← READ NEXT ROW		f OSZ	31 33	PREPARE FOR PROGRAM 2.2 ← BRANCH TO MERGE POINT
	H XZ I	35 24			GTO A	22 11	
	H XZ Y	35 52			2	02	
	f LBL E	31 25 15		110	.	83	
	f C	32 22 15			2	02	
	H R↓	35 53			GTO 9	22 09	
	+	61					
	H XZ I	35 24					
	H XZ Y	35 52					
	f LBL E	31 25 15					
	f C	32 22 15					

REGISTERS

0	1	2	3	4 USED	5	6	7	8	9
S0	S1	S2	S3	S4 USED	S5	S6	S7	S8	S9
A	B	C USED	D	E	I				

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
			<u>NOTE:</u>				
			TO RECORD				
			CARD 2:				
			1. KEY IN				
			STEPS 1-112				
			ON PAGE 10.				
			2. RECORD				
			ON SIDE 1				
			OF CARD 2				
			3. CLEAR				
			PROGRAM				
			4. KEY IN				
			STEPS 1-111				
			ON PAGE 12.				
			5. RECORD ON				
			SIDE 2 OF				
			CARD 2.				

LABELS				FLAGS		SET STATUS		
A CONTINUE	B	C	D n RESET	E ERROR	0 USED	FLAGS	TRIG	DISP
a	b $\div 100$	c $\times 100$	d MOVE UP PIVOT	e READ	1 USED	ON OFF 0 ☐ ☒	DEG ☒	FIX ☒
0	1 USED	2	3	4 USED	2 USED	1 ☐ ☒	GRAD ☐	SCI ☐
5	6	7	8 USED	9 USED	3 USED	2 ☐ ☒	RAD ☐	ENG ☐
						3 ☐ ☒		n <u>2</u>

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	OSP 2	23 02	001 TO 061, READ ROW IN REVERS ORDER AND DO BACKWARD SUBSTITUTION		H RV	35 53	PRINT 2 AND X_i $i=1,2,\dots,N$
	H RC I	35 34			f GSB 8	31 22 08	
	9 FRAC	32 83			f DSE	31 33	
	ENTER ↑	41			GTO 2	22 02	
	f c	32 22 13	↑ SET UP INDEXES		GTO 4	22 04	
	+	61			f LBL B	31 25 12	
	H ST I	35 33			H RC I	35 34	
	f LBL 1	31 25 01			9 FRAC	32 83	
	H RC I	35 34	SET UP INDEXES		ENTER ↑	41	
010	9 FRAC	32 83			f c	32 22 13	
	f c	32 22 13			+	61	
	H RC I	35 34			H ST I	35 33	
	f INT	31 83			H RV	35 53	
	-	51		070	I	01	
	I	01			H XZY	35 52	
	+	61			f LBL 3	31 25 03	
	H RC I	35 34			OSP 0	23 00	
	f INT	31 83			H XZY	35 52	
	H XZI	35 24			H SPACE	35 84	
020	f b	32 22 12			f -X-	31 84	
	+	61			H XZI	35 24	
	H XZI	35 24			H XZY	35 52	
	f LBL E	31 25 15			RCL (i)	34 24	
	f c	32 22 15	← READ ROW	080	f ISE	31 34	
	2	02			f GSB 7	31 22 07	
	4	04			OSP (i)	23 24	
	RCL (i)	34 24			f -X-	31 84	
	f DSE	31 33			H RV	35 53	
	f a	32 22 11			f GSB 8	31 22 08	
030	RCL 0	34 00			f DSE	31 33	
	÷	81	← FIND X_K		GTO 3	22 03	
	f GSB 7	31 22 07			f LBL 4	31 25 04	
	STO (i)	33 24			CL X	44	
	H RV	35 53	← STO X'S IN TOP HALF OF MEMORY	090	OSP 2	23 02	
	f c	32 22 13			H RTN	35 22	
	H ST I	35 33			9 LBL f a	32 25 11	
	f DSE	31 33			H XZY	35 52	
	GTO 1	22 01			RCL (i)	34 24	
	2	02			f GSB 7	31 22 07	
040	5	05	034-060 MOVE X'S TO REGISTERS 12, ..., N.		RCL (i)	34 24	
	H RC I	35 34			f DSE	31 33	
	f c	32 22 13			H XZI	35 24	
	-	51			H RV	35 53	
	H LST X	35 82		100	f GSB 7	31 22 07	
	H RC I	35 34			X	71	
	+	61			-	51	
	H ST I	35 33			f DSE	31 33	
	H RV	35 53			GTO f a	22 31 11	
	I	01			H RTN	35 22	
050	f LBL 2	31 25 02			f LBL 7	31 25 07	
	f GSB 7	31 22 07			H XZI	35 24	
	RCL (i)	34 24			f LBL 8	31 25 08	
	f ISE	31 34			H XZY	35 52	
	f GSB 7	31 22 07			H XZI	35 24	
	STO (i)	33 24		110	H RTN	35 22	
	f ISE	31 34					

REGISTERS

0 USED	1 X_1	2 X_2	3 X_3	4 X_4	5 X_5	6 X_6	7 X_7	8 X_8	9 X_9
S0 X_{10}	S1 X_{11}	S2 X_{12}	S3	S4	S5 USED	S6	S7	S8	S9
A	B	C USED	D	E	I				

