

Program Title 67 - 5x5, 4x4, 3x3 Matrices OR UNKNOWN
Equations

Contributor's Name E. J. ROBINSON

Address 70, Rue des Belles-Feuilles

City PARIS Country FRANCE Postal Code 75116

Program Description, Equations, Variables Program calculates cofactors and the determinant (if one exists) for 5x5, 4x4 and 3x3 matrices which are entered directly or by data card. Inverse values replace initial matrix in registers. A vector of constants can then be entered for the calculation of unknowns if desired.

(A) = matrix of coefficients

X = matrix of unknowns (a vector)

B = matrix of constants

$1/(A)$ = inverse of matrix of coefficients

$X = \frac{1}{(A)} \cdot B$

If no determinant exists the program will repetitively pause, showing the zero diagonals or show ERROR. Usually, if at least 2 diagonals are non-zero the determinant exists

Operating Limits and Warnings None except not disturb stack between data entry and determinant calculation.

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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Sketch(es)										Register locations										
R	0	w:	1			a_{11}	a_{12}	a_{13}	a_{14}	a_{15}						0	1	2	3	4
R	0	w:	2			a_{21}	a_{22}	a_{23}	a_{24}	a_{25}			3×3			5	6	7	8	9
R	0	w:	3			a_{31}	a_{32}	a_{33}	a_{34}	a_{35}						10	11	12	13	14
R	0	w:	4			a_{41}	a_{42}	a_{43}	a_{44}	a_{45}			4×4			15	16	17	18	19
R	0	w:	5			a_{51}	a_{52}	a_{53}	a_{54}	a_{55}			5×5			20	21	22	23	24
C	0	l	u	m	n:	1	2	3	4	5										

Sample Problem(s)

$$\begin{matrix}
 \textcircled{1} & 1 & 1 & 1 & 1 \\
 2 & \textcircled{3} & -4 & 6 & 0 \\
 0 & 2 & \textcircled{1} & 5 & 0 \\
 3 & 3 & 0 & \textcircled{2} & 1 \\
 4 & -1 & -3 & 2 & \textcircled{0}
 \end{matrix}
 \begin{matrix}
 15 \\
 22 \\
 21 \\
 32 \\
 11
 \end{matrix}$$

(A) B

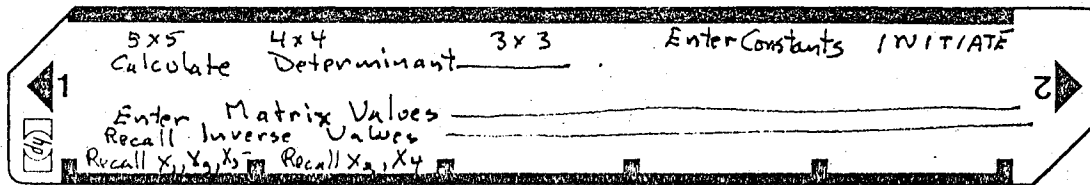
Shortly after program begins calculation of determinant there will be a pause and the number 24.8 will be shown. This indicates a zero diagonal value. The program will skip to the other diagonals and then return to this one, which will no longer be zero. Key diagonal locations are circled

Solution(s) Determinant = 190

$$\begin{matrix}
 \text{Inverse:} & \begin{bmatrix} -0.30 & -0.20 & 0.10 & 0.30 & 0.20 \\ -0.37 & 0.05 & -0.05 & 0.37 & -0.21 \\ -0.16 & -0.26 & 0.26 & 0.16 & 0.05 \\ 0.18 & 0.03 & 0.17 & -0.18 & 0.07 \\ 1.65 & 0.38 & -0.48 & -0.65 & -0.12 \end{bmatrix} & \begin{matrix} X_1 = 5 \\ X_2 = 4 \\ X_3 = 3 \\ X_4 = 2 \\ X_5 = 1 \end{matrix}
 \end{matrix}$$

1
(A) X

Reference(s)



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter side one and side two			
2	Initiate			
3	Enter data card on matrix			
	Coefficients row by row			
	Column 1	Value		Value
	Column 2	Value		Value
	Column 3	Value		Value
	(If 4x4 or 5x5) Column 4	Value		Value
	(If 5x5) Column 5	Value		Value
	Repeat this step until all rows entered.			
4	Calculate determinant and inverse of matrix			
	For 5x5			Determinant
	For 4x4			Determinant
	For 3x3			Determinant
5	If desired, the inverse values can be recalled, row by row			
	Column 1			Inverse
	Column 2			Inverse
	Column 3			Inverse
	(If 4x4 or 5x5) Column 4			Inverse
	(If 5x5) Column 5			Inverse
6	To solve for unknown equation, input the vector of constants			
		1 st Const		1 st Const
		2 nd Const		2 nd Const
		3 rd Const		3 rd Const
	for 4x4 and 5x5 or 0	4 th Const or 0		4 th Const or 0
	for 5x5 or 0	5 th Const or 0		5 th Const or 0
7	Recall unknowns			
		No!		X_1
		No!		X_2
		No!		X_3
	for 4x4 and 5x5	No!		X_4
	for 5x5	No!		X_5



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Program Listing I

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STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	LBL a	32 25 11	Calculate Determinant		F3?	35 71 03	If one or more diagonal was zero go back to calculate
	RAD	35 42			gto c	22 31 13	
	LBL b	32 25 12			0	00	
	CF 1	35 61 01		060	gsb a	32 22 11	
	LBL c	32 25 13			gsb 0	31 22 00	
	h↓	35 53			152	31 34	
	3	03			gsb 6	31 22 06	
	cos	31 63			gsb 6	31 22 06	
	X>0	31 81			DSZ	31 33	
010	gto 4	22 04			DSZ	31 33	
	4	04	If not a 5x5 matrix or already calculated go to next operation		↓	35 53	Divide cofactors by the determinant to produce inverse values
	gsb a	32 22 11			LBL 8	31 25 08	
	gsb 6	31 22 06			STO ÷ i	33 81 24	
	gsb 6	31 22 06		070	DSZ	31 33	
	DEG	35 41			gto 8	22 08	
	LBL 4	31 25 04			STO ÷ 0	33 81 00	
	F 17	35 71 01			RTN	35 22	
	gto 3	22 03			LBL 6	31 25 06	
	3	03			gsb 5	31 22 05	
020	gsb a	32 22 11			LBL 5	31 25 05	
	gsb 6	32 22 12	If already calculated go to next operation		gsb 7	31 22 07	
	gsb 6	31 22 06			LBL 6	32 25 12	
	gsb 7	31 22 07			gsb 7	31 22 07	
	gsb 0	31 22 00		080	LBL 3	31 25 03	
	gsb 6	32 22 12			gsb 7	31 22 07	
	gsb 7	31 22 07			LBL 4	31 25 04	
	SF 1	35 51 01			gsb 7	31 22 07	
	LBL 3	35 25 03			152	31 34	
	F 27	35 71 02			RTN	35 22	
	gto 4	22 04			LBL 7	31 25 07	
	2	02	If already calculated go to next operation		↓	35 53	
	gsb a	32 22 11			STO ÷ i	33 71 24	
	gsb 3	31 22 03			RCL I	35 34	
	gsb 5	31 22 05		090	5	05	
	gsb 7	31 22 07			÷	81	
	gsb 7	31 22 07			INT	31 83	
	gsb 0	31 22 00			h↑	35 54	
	gsb 3	31 22 03			FRAC	32 83	
	gsb 5	31 22 05			+	61	
040	gsb 3	31 22 03			5	05	
	LBL 4	31 25 04	If already calculated go to next operation		x	71	
	SF 2	35 51 02			RCL I	35 34	
	LBL 2	31 25 02			X ⇒ Y	35 52	
	F 07	35 71 00		100	-	51	
	gto 1	22 01			h↑	35 54	
	1	01			LSX	35 82	
	gsb a	32 22 11			X ⇒ I	35 24	
	gsb 4	31 22 04			↓	35 53	
	gsb 6	32 22 12			+	61	
050	DSZ	31 33			RCL i	34 24	
	gsb 0	31 22 00			X ⇒ Y	35 52	
	gsb 4	31 22 04			STO I	35 33	
	gsb 6	31 22 06			CLX	44	
	gsb 6	32 22 12		110	RCL i	34 24	
	SF 0	35 51 00			h↑	35 54	
	LBL 1	31 25 01			STO I	35 33	

REGISTERS

0	a ₁₁	1	a ₁₂	2	a ₁₃	3	a ₁₄	4	a ₁₅	5	a ₂₁	6	a ₂₂	7	a ₂₃	8	a ₂₄	9	a ₂₅
S0	a ₃₁	S1	a ₃₂	S2	a ₃₃	S3	a ₃₄	S4	a ₃₅	S5	a ₄₁	S6	a ₄₂	S7	a ₄₃	S8	a ₄₄	S9	a ₄₅
A	1..	B	2..	C	3..	D	4..	E	5..	F	6..	G	7..	H	8..	I	9..	J	0..

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
	CLX	44			STO I	35 33	
	LSTX	35 82		170	gTO i	22 24	
	h↓	35 53			LBL D	31 25 14	
	X	71			DSZ	31 33	
	STO +i	33 61 24			gSB E	31 22 15	
	h↓	35 53			gTO 6	22 06	
	X = Y	35 52			LBL C	31 25 13	
120	X = I	35 24			gSBA	31 22 11	
	RCL i	34 24			ISZ	31 34	
	X = Y	35 52			gTO 6	22 06	
	STO I	35 33			STO e	32 25 15	
	h↓	35 53		180	DEG	35 41	
	STO ÷ i	33 81 24			SF 1	35 51 01	
	ISZ	31 34			CF 0	35 61 00	
	RTN	35 22			CF 2	35 61 02	
	LBL a	32 25 11			CL REG	31 43	
	6	06			LBL E	31 25 15	
130	.	83			DSZ	31 33	
	2	02			LBL A	31 25 11	
	X = Y	35 52			LBL B	31 25 12	
	X	71			F 3?	35 71 03	
	STO I	35 33		190	STO i	33 24	
	RCL i	34 24			1	01	
	X = 0	31 51	Is diagonal value zero?		RCL i	34 24	
	gTO 6	22 06			LBL 6	31 25 06	
	h↑	35 54			ISZ	31 34	
	CHS	42			F 1?	35 71 01	
140	STO i	33 24			RTN	35 22	
	CLX	44			gSB 6	31 22 06	
	LSTX	35 82			gSB 6	31 22 06	
	STO I	35 33			gSB 6	31 22 06	
	CLX	44		200	LBL 6	31 25 06	
	1	01			RCL i	34 24	
	CHS	42			+	61	
	gSB 9	31 22 09			ISZ	31 34	
	gSB 9	31 22 09			RTN	35 22	
	STO x i	33 71 24			32 25 14	32 25 14	
150	CLX	44			0	00	
	STO I	35 33			F 2?	35 71 02	
	RTN	35 22			STO I	35 33	
	LBL 9	31 25 09			h↓	35 53	
	gSB 9	31 22 09		210	gSB 9	31 22 09	
	LBL 9	31 25 09			gSB 9	31 22 09	
	STO x i	33 71 24			STO x i	33 71 24	
	LBL 0	31 25 00			X = I	35 24	
	X = I	35 24			1	01	
	5	05			9	09	
160	+	61			-	51	
	X = I	35 24			5	05	
	RTN	35 22			X = Y	35 52	
	LBL 6	31 25 06			X = Y?	32 51	
	SF 3	35 51 03		220	CLX	44	
	X = Y	35 52			X = I	35 24	
	Pause	35 72			CF 1	35 61 01	
	h↑	35 54			CF 3	35 61 03	
	LSTX	35 82			RTN	35 22	

Is diagonal value zero?

If not zero exchange last diagonal with new one and change sign of column values in which the new diagonal was located

If diagonal value zero, set flag 3 and go to next diagonal after displaying register number

Initiate

Summation of columns for X_n

Multiply constants by inverse values

LABELS					FLAGS	SET STATUS			
A	B	C	D	E		FLAGS		TRIG	DISP
Enter Recall	Enter Recall	Enter Recall	Enter Recall	Enter Recall	0	Used			
5x5 Determinant	4x4 Determinant	3x3 Determinant	Input of Constants	/nit.	1	Used	ON OFF	DEG ☒	FIX ☒
USED	USED	USED	USED	USED	2	Used	0 ☒ ☐	GRAD ☐	SCI ☐
USED	USED	USED	USED	USED	3	Used	1 ☒ ☐	RAD ☐	ENG ☐
							2 ☒ ☐		n <u>2</u>
							3 ☒ ☐		