50089 Program Description I

Program Title 5TH DEGREE EQUATION

Contributor's Name ATTILIO FARINA
Address VIA VENTIMIGLIA 162
City TORINO Country ITALY Postal Code 10127

Program Description, Equations, Variables

PROGRAM SOLVES 5TH DEGREE EQUATIONS OF THE TYPE:

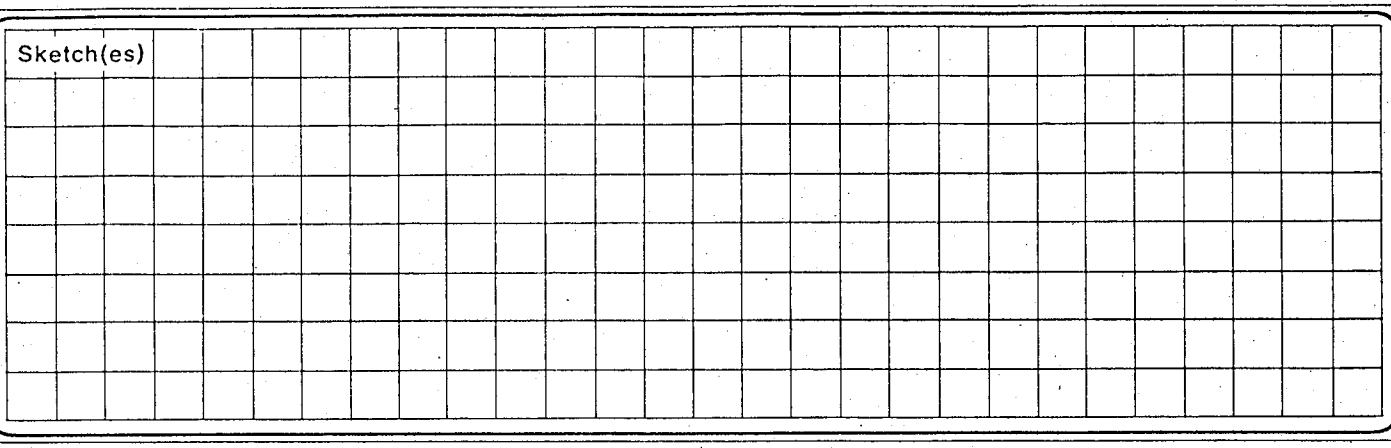
$$x^5 + a x^4 + b x^3 + c x^2 + d x + e = 0$$

ANY COEFFICIENT MAY BE ZERO SO THAT ALSO 4TH OR 3RD DEGREE EQUATIONS CAN BE HANDLED. SPECIAL PROVISIONS HAVE BEEN TAKEN TO AVOID STOPS OR FAULTY RESULTS.
PROGRAM STOPS AFTER CALCULATION IS MADE AND ROOTS ARE DISPLAYED IN SEQUENCE IN RECTANGULAR OR POLAR FORM; IF RECTANGULAR FORM IS SELECTED REAL PART IS SHOWN FIRST AND IMAGINARY PART THEN; IF POLAR FORM IS SELECTED MAGNITUDE IS SHOWN FIRST AND ARGUMENT SECOND. ROOTS DISPLAY MAY BE REPEATED AT WILL IN ANY FORM. COEFFICIENTS ARE SAVED IN REGISTERS FOR CHECKING.
FOR REFERENCE SEE PROGRAM 00068 D.

Operating Limits and Warnings

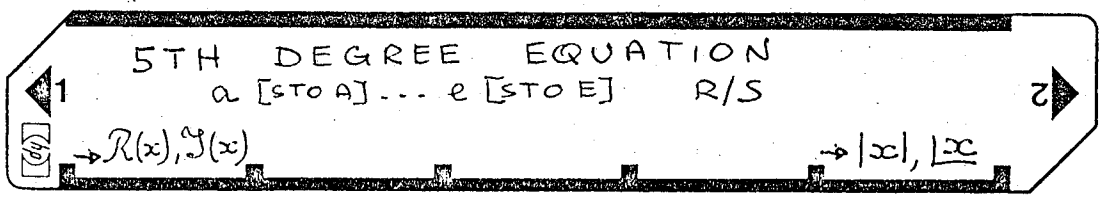
50089 Program Description II

Sketch(es)



Sample Problem(s)	(I)	(II)	(III)	(IV)	(V)	(VI)
[STO] [A]	2501	1.10^{-3}	1	-8.02	2	0
[STO] [B]	27	-1.10^{3}	1	24.1201	1	0
[STO] [C]	1	1.10^{-3}	1	-32.2404	1	0
[STO] [D]	0	0	1	16.1604	2	0
[STO] [E]	0	0	0	0	1	1
	[R/S]	[R/S]	[R/S]	[R/S]	[R/S]	[R/S]
	0.000	0.000	0.000	0.000	0.000	0.000
	[A]	[A]	[E]	[A]	[E]	[E]
Solutions	0.000	0.000	0.000	2.000	1.000	1.000
	0.000	0.000	0.000	0.000	180.000	180.000
	-0,005	1.10^{-6}	1.000	2.010	1.000	1.000
	-0,019	0.000	-144.000	0.000	180.000	-108.000
~~Solution(s)~~						
	-0,005	31.622	1.000	2.010	1.000	1.000
	0,019	0.000	144.000	0.000	180.000	108.000
	-2500,989	-31.623	1.000	0.000	1.000	1.000
	0.000	0.000	-72.000	0.000	-60.000	-36.000
	0.000	0.000	1.000	2.000	1.000	1.000
	0.000	0.000	72.000	0.000	60.000	36.000

~~Reference(s)~~ NOTE. cases IV and V cause a stop in program 00068D; cases I, III, and VI yield incorrect answers; case II is solved by program 00068D in about 14 minutes instead of 2 minutes 20 seconds required by this program; moreover the smallest root is given as $9.8\ 10^{-7}$ instead of 1.10^{-6}



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program (both sides)			
2	Enter coefficients	a	STO A	a
		b	STO B	b
		c	STO C	c
		d	STO D	d
		e	STO E	e
3	Calculate		R/S	0.000
4	Display roots in rectangular form		A	ℛ(x), ℑ(x)
5	" " " polar "		E	|x|, ∠x
	Coefficients are saved in registers A ... E			

HEWLETT-PACKARD EUROPE

30089 - Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	CLX	44	
	STO6	3306	
	STO I	3533	
	RCL E	3415	
	X=0?	3151	
	RCL A	3411	Find one real root and coeffi- cients of new 4TH deg. equation
	X>0?	3181	
	SF2	355102	
	RCL D	3414	
010	RCL E	3415	
	→ P	3272	
	X=0?	3151	
	CF1	356101	
	RCL A	3411	
	GSB2	312202	
	P≠S	3142	
	RCL1	3401	
	RCL3	3403	
	X	71	
020	4	04	
	RCL4	3404	
	X	71	Starting from 4TH degree equation a 3RD deg. equation is derived
	−	51	
	STO0	3300	
	RCL3	3403	
	X²	3254	
	RCL2	3402	
	4	04	
	X	71	
030	RCL1	3401	
	X²	3254	
	−	51	
	RCL4	3404	
	X	71	
	−	51	
	STO6	3306	
	ISZ I	3134	Find one real root of 3RD deg.
	SF1	355101	
	GSB2	312202	
040	X=Y?	3251	
	GTO7	2207	
	RCL6	3406	
	STO0	3300	
	RCL5	3405	
	ST÷0	338100	
	*LBL7	312507	Calculate other roots of 3RD deg. equation and select the greatest real root
	RCL2	3402	
	RCL5	3405	
	−	51	
050	2	02	
	÷	81	
	ENT↑	41	
	X²	3254	
	RCL0	3400	
	X>Y?	3281	
	GTO7	2207	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	GSB5	312205	
	+	61	
	X>Y?	3281	
060	STO5	3305	
	*LBL7	312507	
	RCL5	3405	
	2	02	
	÷	81	
	STO0	3300	Using coefficients of 4TH deg. equation and greatest real root of 3RD deg. two 2ND degree equations are derived
	STO7	3307	
	RCL1	3401	
	STO8	3308	
	X	71	
070	RCL3	3403	
	−	51	
	STO9	3309	
	RCL5	3405	
	EEX	43	
	3	03	
	÷	81	
	RCL0	3400	
	X²	3254	
	RCL4	3404	
080	GSB5	312205	
	ST+7	336107	
	ST-0	335100	
	X>Y?	3281	
	SF2	355102	
	X>Y?	3281	
	ST÷9	338109	
	RCL1	3401	
	X²	3254	
	RCL2	3402	
090	RCL5	3405	
	−	51	
	4	04	
	X	71	
	GSB5	312205	
	F2?	357102	
	RCL9	3409	
	ST-1	335101	
	ST+8	336108	
	RCL0	3400	1ST 2ND degree equation solved
100	RCL1	3401	
	GSB8	312208	
	RCL7	3407	
	RCL8	3408	
	P≠S	3142	
	*LBL8	312508	
	CHS	42	
	4	04	2ND 2ND degree equation solved
	÷	81	
	STO1	3301	
110	STO3	3303	
	X²	3254	
	X≤Y?	3271	

REGISTERS

0	1 R(X3)	2 J(X3)	3 R(X2)	4 J(X2)	5 R(X1)	6 J(X1)	7 used	8 used	9
S0 used	S1 R(X5)	S2 J(X5)	S3 R(X4)	S4 J(X4)	S5 used	S6 used	S7 used	S8 used	S9 used

A	B	C	D	E	I
a	b	c	d	e	counter

STEP	KEY ENTRY	KEY CODE	COMMENTS
	GTO 4	2204	
	GSB 5	31 22 05	
	ST+ 1	33 61 01	
	ST- 3	33 51 03	
	ENT↑	42	
	*LBL 4	31 25 04	
	GSB 5	31 22 05	
120	STO 2	3302	
	CHS	42	
	STO 4	3304	
	ENT↑	41	
	*LBL 5	31 25 05	
	−	51	
	ABS	35 64	
	√x	31 54	
	RTN	35 22	END OF CALCULATION
	*LBL 2	31 25 02	
130	→P	32 72	
	9	09	
	+	61	
	LOG	31 53	
	INT	31 83	
	10^x	32 53	
	STO 7	33 07	
	CLX	44	
	STO 5	33 05	
	F1?	35 71 01	
140	1	01	
	F2?	35 71 02	
	CHS	42	
	STO 8	33 08	
	*LBL 6	31 25 06	Routine to find one real root by iterative method
	RCL 5	34 05	
	RCL 5	34 05	
	RCL 7	34 07	
	RCL 8	34 08	
	X	71	
150	+	61	
	STO 5	33 05	
	X=Y?	32 51	
	GTO i	22 24	
	ENT↑	41	
	ENT↑	41	
	GSB i	31 22 24	
	X=0?	31 51	
	RTN	35 22	
	RCL 8	34 08	
160	X	71	
	X<0?	31 71	
	GTO 6	22 06	
	.	83	
	1	01	
	STX 7	33 71 07	
	LOG	31 53	
	STX 8	33 71 08	
	GTO 6	22 06	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	*LBL 0	31 25 00	
170	P≠S	31 42	
	RCL A	34 11	
	+	61	
	STO 1	33 01	5TH degree polynomial evaluation and synthetic division
	X	71	
	RCL B	34 12	
	+	61	
	STO 2	3302	
	X	71	
	RCL C	34 13	
180	+	61	
	STO 3	3303	
	X	71	
	RCL D	34 14	
	+	61	
	STO 4	3304	
	X	71	
	RCL E	34 15	
	+	61	
	P≠S	31 42	
190	RTN	35 22	
	*LBL 1	31 25 01	
	RCL 2	34 02	
	−	51	3RD degree polynomial evaluation
	X	71	
	RCL 0	34 00	
	+	61	
	X	71	
	RCL 6	34 06	
	−	51	
200	RTN	35 22	
	*LBL E	31 25 15	set flag 0 to polar display
	SF 0	35 51 00	
	GTO 9	22 09	
	*LBL A	31 25 11	
	CF 0	35 61 00	
	*LBL 9	31 25 09	
	6	06	
	STO I	35 33	
	GSB 3	31 22 03	Display roots routine
210	4	04	
	STO I	35 33	
	*LBL 3	31 25 03	
	RCL i	34 24	
	DSZ I	31 33	
	RCL i	34 24	
	F0?	35 71 00	
	→P	32 72	
	PRT X	31 84	
	R↓	35 53	
220	PRT X	31 84	
	DSZ I	31 33	
	GTO 3	22 03	
	P≠S	31 42	
	RTN	35 22	

LABELS

A Display R	B	C	D	E Display P
a	b	c	d	e
0 5TH Deg. Eval.	1 3RD Deg. Eval.	2 used	3 used	4 used
5 used	6 used	7 used	8 used	9 used

FLAGS

0	used
1	used
2	used
3	

SET STATUS

FLAGS	ON	OFF
0	☐	☑
1	☑	☐
2	☐	☑
3	☐	☑

TRIG	
DEG	☑
GRAD	☐
RAD	☐

DISP	
FIX	☑
SCI	☐
ENG	☐
n	3