Roots of a Quadratic Equation

Programmer: Dr. Bill Hazelton

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Line	Instruction	User Instructions
R001	LBL R	
R002	SF 10	(Enter using FLAGS 1 .0)
R003	QUADRATIC ROOTS	EQN RCL Q RCL U, etc., ENTER to end.
R004	PSE	
R005	ENTER A	EQN RCL E RCL N, etc., ENTER to end.
R006	PSE	
R007	INPUT A	
R008	ENTER B	EQN RCL E RCL N, etc., ENTER to end.
R009	PSE	
R010	INPUT B	
R011	ENTER C	EQN RCL E RCL N, etc., ENTER to end.
R012	PSE	
R013	INPUT C	
R014	RCL B	
R015	x^2	
R016	RCL A	
R017	RCL C	
R018	×	
R019	4	
R020	×	
R021	–	
R022	STO D	
R023	$x < 0$?	
R024	VIEW D	If no real roots, program stops here (see Note 2)
R025	√x	
R026	RCL– B	
R027	RCL÷ A	
R028	2	
R029	÷	
R030	STO P	
R031	1ST ROOT	EQN 1 RCL S RCL T SPACE, etc.
R032	PSE	
R033	VIEW P	
R034	RCL D	
R035	$x = 0$?	
R036	RTN	If one real root, program stops here (see Note 3)
R037	√x	
R038	RCL+ B	
R039	RCL÷ A	

Roots of a Quadratic Equation

Line	Instruction	User Instructions
R040	2	
R041	÷	
R042	+/–	
R043	STO Q	
R044	2ND ROOT	EQN 2 RCL N RCL D SPACE, etc.
R045	PSE	
R046	VIEW Q	
R047	CF 10	(Enter using FLAGS 2 .0)
R048	RTN	

Notes

(1) A simple program to calculate the real roots of a quadratic equation in standard form: $ax^2 + bx + c = 0$.

(2) If there are no real roots, the program stops and shows a negative value in the D storage location. The user should them use the value in D to calculate the complex roots of the equation, if needed.

(3) If there is a single real root for the equation, the value in storage location D is equal to zero, so after showing 1ST ROOT, then the value in storage location P, the program ends.

(4) If there are two real roots, the program continues, displays 2ND ROOT, then shows the value in storage location Q.

(5) This program sets Flag 10, so that equations can be displayed as prompts. If the program finishes before displaying two real roots, Flag 10 remains set. If the program completes, then Flag 10 is cleared.

(6) The program was written to minimize branching, and so the number of labels.

Theory

The solution to a quadratic equation in the form $ax^2 + bx + c = 0$ is:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

where $b^2 - 4ac$ is known as the discriminant. The discriminant, commonly termed Δ, is stored in storage location D.

If Δ is positive, the equation has two real roots. If Δ = 0, the equation has a single, real root, i.e., it is a perfect square. If Δ is negative, the equation has two complex roots. Solution of the complex roots requires the user to calculate these by hand. The program supplies the value of Δ in D.

Roots of a Quadratic Equation

Running the Program

Press XEQ R.

Program displays QUADRATIC ROOT briefly, then ENTER A briefly, then prompts:
A?
Key in the value of a from the equation. Press R/S.

Program displays ENTER B briefly, then prompts:
B?
Key in the value of b from the equation. Press R/S.

Program displays ENTER C briefly, then prompts:
C?
Key in the value of b from the equation. Press R/S.

If there are no real roots, the program displays:
D =
and the value of the discriminant, Δ, which will be negative. This indicates that there are no real roots. Press the C key (also the ON/OFF key) to leave the program. (If you press R/S, you will get a SQRT(NEG) error message. Press the C key to clear the message and end the program.)

If there are real roots, the program displays 1ST ROOT briefly, then shows:
P =
and the value of the first root of the equation.
Press R/S to continue.

If there was just one real root, the program now ends and returns to the normal display.
The one root will be in the upper line of the display, and the lower line will show zero.

If there was a second real root, the calculator displays 2ND ROOT briefly, then shows:
Q =
and the value of the second root of the equation.
Press R/S to end the program.
The two roots will be shown in the display.

Sample Computations

1. Solve $4x^2 + x + 8 = 0$

   There are no real roots, so the program displays D = –127.0000

2. Solve $4x^2 + 8x - 6 = 0$

   There are two real root for this equation.

   Solutions: 1st Root P = 0.581139, 2nd Root Q = –2.581139

3. Solve x2 + 2x + 1 = 0

   There is just one root for this equation.

   Solution: 1st Root P = –1.00000

Roots of a Quadratic Equation

Storage Registers Used

A Value of a in equation

B Value of b in equation

C Value of c in equation

D Discriminant, Δ

P Solution of the first root

Q Solution of the second root

Statistical Registers: not used

Labels Used

Label **R** Length = 232 Checksum = DDFB

Use the length (LN=) and Checksum (CK=) values to check if program was entered correctly. Use the sample computation to check proper operation after entry.