

# POLYNOMIALS

*All In One*

$$\begin{array}{c} x^2 + 7x - 3 \\ 4a^3 + 7a^2 + a \\ nm^2 - m \\ 3x - 2 \\ 5 \end{array}$$

**Version 3.2**

*“THE STORING UPDATE”*

by Anthony Cagliano

## Introduction

Thank you for downloading *Polynomials All In One*, your comprehensive tool for polynomial math, designed and programmed by Anthony Cagliano, Internet alias "ACagliano". This is the third version and second remake of this tool, and a bug fix for the division algorithm, to remove the divide-by-zero bug. This program is a stand-alone executable, written in TI-Basic, and will render the result of sequential polynomial operations. Like its predecessor, this program allows you to input the polynomials as strings, not at coefficient lists the way other tools of this kind require. However, unlike my prior versions of this tool, this version is able to chain polynomial operations using a specially formatted input string. The remainder of this guide will explain how to install and use this program, complete with screenshots. Clocking in at about 5.5 kB, this program is a handy alternative to some of the bulky Flash Applications that provide the same features.

This program is fully compatible with the Z80 line of Texas Instruments graphing calculators. This includes the following models:

- TI-83+/84+
- TI-83+ SE/84+ SE
- TI-84+ Emulator on the TI-Nspire

This program has not been tested on a device not listed above. While it may still work on one of them, we advise you not to attempt to run this program on any device not listed above. It may not work properly and may cause unpredictable results.

## Download and Installation

If you are reading this, clearly you don't need help in downloading the program. However, if by means unknown to me you managed to breach the time continuum and are reading this before actually downloading it and have no idea where to get this tool from, a list of download locations is below.

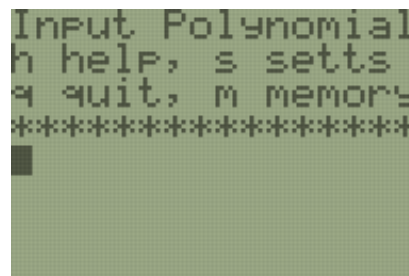
- <http://clrhme.org/products/>
- <http://cemetech.net/programs/>
- <http://ticalc.org/pub/83plus/basic/math/>

Once you get this program, you will need to extract the zip file. WinRAR on Windows should get the job done. Macintosh computers should be able to do it out-of-the-box. Inside the new folder that will be created you should see this document and the program, a .8xp file.

After locating the program file, you will need to send it to your calculator using your favorite flavor of calculator connectivity software on your computer. Some options are TI-Connect and TiLp. You will also need a calculator connectivity cable, which is simply a USB A to mini B cable. With the calculator plugged into your computer and on the home screen, launch the connectivity software and follow its instructions to send the program to your device. If you have DoorsCS or MirageOS or another shell on your calculator, you can send this to your device's Archive memory. If not, it will need to be in RAM. Your connectivity software may allow you to choose one or the other when sending.

## Usage

Using this program is fairly straightforward, but takes some getting used to. First, press the [Prgm] key and scroll down the list until you see *POLYA/O3*. Press [Enter] twice. The program should start. You will immediately be prompted to input your polynomial (see the image to the right). There is no splash screen. I broke tradition and kind of made the splash screen part of the final result display.

A screenshot of a monochrome LCD screen showing the program's startup menu. The text on the screen is: "Input Polynomial", "h help, s setts", "q quit, m memory", and a separator line of asterisks "\*\*\*\*\*". A small black cursor is visible on the line following the asterisks.

```
Input Polynomial
h help, s setts
q quit, m memory
*****
█
```

Input to this program is similar to postfix notation, but the operator and operand strings are separated by a colon (:). You will first input a list of operators in the order they occur, a colon, and then a list of operands in the order they occur (with each one enclosed in parenthesis). There are also special operand characters you can use to add a special function to the list. The table below lists every operand or special character you can use.

Operator	Function
H or h	Show in-program help
Q or q	Exit the program
S or s	Access settings menu
M or m	Access memory
W	First character in input string: disable showing work for this function
+	Addition
-	Subtraction
*	Multiplication
/	Division
D or d	Derivative

I or i	Integral
Z or z	Find zeroes

Three different images are shown below, each demonstrating a different input queue. In the one on the left, the second operand is added to the first and the third is added to that result. In the middle one, the second operand will be multiplied by the first and the third will be subtracted from that. In the last one, the second operand will be multiplied by the first and then the derivative will be taken twice. Additionally, work will be shown after each step.

```
Input Polynomial
or /h for help
or /q to quit
*****
++: (X+1)(X-2)(X2
-1)■
```

```
Input Polynomial
or /h for help
or /q to quit
*****
*=: (X2-4)(X+2)(3
X-7)
```

```
Input Polynomial
or /h for help
or /q to quit
*****
W*DD: (X2+5X-4)(2
X-9)
```

After the entire string has been processed, the result will be displayed with a splash screen of sorts. If the show work option is used on a string, the program will skip the last show work iteration and simply render the final result as normal. Pressing [Enter] at this time will return to the input polynomial prompt, where you can input another string or type “/Q” to exit the program.

## New Feature – Settings Menu

As you will notice the first time you look at the input screen of Version 3.0, there are two new options available. The first is *Options (ops)*, accessed by typing “S” or “s” (for *settings*). Entering this will bring up a list of configurable settings. In Version 3.0, you have *Show Work* and *Save*

*Exprs.* The *show work* feature is the same as that from the previous program versions (where it renders the partial result after each stage of the computation), it is just toggled here instead of directly in the input string. When showing work is set to active, it will show work on every expression entered into the main screen. You may turn OFF this feature for specific polynomials by prepending the input string with a W. The *save exprs* feature allows this program to save polynomial strings you input. When it is active, you will have a third option, *Max Entries*. More information on this will be in the next section. To navigate this menu, use the up and down arrow keys. To toggle an option, use the [2<sup>nd</sup>] key. Increment or decrement the *Max Entries* number by using the left and right arrow keys. You can use the [Enter] or [Clear] keys to return to the main prompt.

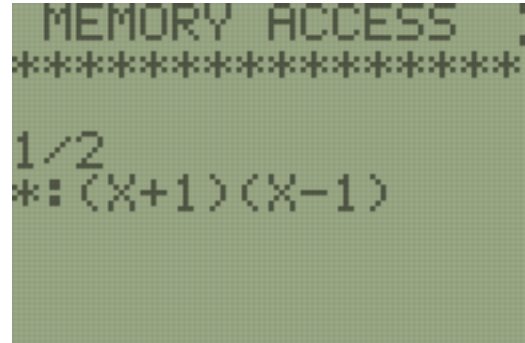
```
- PRGM OPTIONS -
*****
>Show Work      N
  Save Exprs    N
```

```
- PRGM OPTIONS -
*****
  Show Work      N
>Save Exprs     Y
  Max Entries: 10
```

### New Feature – “Silent” Input Saving

The second new feature in this version is the ability to save your input expressions for quick re-entry. **This feature is only available to users with Celtic3 or DoorsCS7 installed and active on their calculator.** If you do not have these applications on your device, the program will still function as normal, but the saving feature will be turned off and you will not be able to activate it.

While saving is active, every time you input a polynomial on the prompt screen, after the string is checked for format, it is written to an application variable named *PolySav*. When the number of entries saved is equal to the maximum number of entries, the oldest one is deleted prior to saving. By typing “M” or “m” on the input screen, you can access the memory and scroll through all saved inputs using the left and right arrow keys. You may abort this mode by pressing [Clear] or select the current entry by pressing [2<sup>nd</sup>].



## Algorithms

- String Conversion: Each polynomial operand is split into its coefficient and exponent mathematically for optimal speed. Operands are processed sequentially, by terms of the polynomial. First, X is set to 1 and the term is evaluated. 1 to any power is 1, which leaves the coefficient. Next, X is set to 2, and the term is evaluated again and then the natural log of that divided by the coefficient is divided by the natural log of 2 to yield the exponent. Finally, once this process is repeated for the entire operand, the coefficients are sorted with respect to the exponents, and the exponent list is then discarded.
- Addition/Subtraction: Lists are generated by the string conversion algorithm, padded to equal length and then added or subtracted using the OS's list adding/subtracting routines.

- Multiplication/Division: Lists are generated by the string conversion algorithm, and then long multiplication and long division are conducted. In division, remainders are discarded at this time.
- Derivative/Integral: Chain and reverse chain method are used for derivative and integral respectively. For the derivative, the coefficient and exponent are multiplied to give the new coefficient, and then the exponent is reduced by one. For integral the coefficient is divided by the exponent plus one, and then the exponent is raised by one.
- Zeroes: Zeroes finding is done using a modified rational zeroes test. All factors of the coefficients of the first and last terms are divided and tested. All possible values that equate to zero are returned.



## Legal Notices

This program is distributed as freeware and comes with full rights to distribute and/or modify it to your heart's content. That being said, we strongly discourage people from distributing modified software because we cannot guarantee we will be able to troubleshoot any issues you may have with them.

By using this program, you release and save harmless ClrHome Productions and any of its affiliates from liability for damages associated with its use. Such damage includes but is not limited to: (1) corruption or loss of data on your device, (2) crashing of the calculator (RAM clears), (3) corruption of the Flash memory or the operating system or, (4) in extreme cases the permanent rendering of your device unusable, an event termed "bricking". However please note that while we are required to cover worst case scenarios legally, TI Basic programs are all but harmless.

We are also not responsible for any damage to your math grade that may result from improperly using this program or not following the instructions indicated herein. If you do not understand the instructions given in-program, come back here and consult this document. If you don't understand that, send me an email or contact me some other way listed below.

## Version History

Polynomial Arithmetic Utility: The fledgling version of this program, featuring input by lists and result by list. Broke on pretty much everything.

Polynomials All in One: A rewrite to the previous program, with faster and better algorithms. Input was to strings, which were then converted into lists. Each polynomial was entered separately and only one operation could be done at a time. Had sporadic bugs.

Polynomials All in One v2: An upgrade to version 1 of this program. Algorithms were streamlined. Specially formatted string allows for chaining operations. Improved interface.

- 2.0 b1 – First beta release of this software. Had only addition, subtraction, multiplication, and division working. Division by 1 term caused DOMAIN error.
- 2.0 b2 – Bugs removed from derivative and integral routines, memory recovery between iterations improved. New zeroes finding algorithm introduced.
- 2.0 RC1 – Division bug resolved. Error catching for divide by zero and negative exponents added. Trailing parenthesis removed where possible.
- 2.1 – Ability to show work added via a prepended function character (see Usage).
- 2.2 – Bug fix for persistent division-by-zero error added. Version string updated.
- 2.3 – Glitch in zeroes finding algorithm resolved.

Polynomials with non-integer coefficients are multiplied by a constant to make them integers, then rational zeroes test is used

- 2.4 – Zeroes finding algorithm debugged and streamlined. Inner loop removed, fraction-to-integer algorithm improved
- 3.0 – Settings menu added, saving ability added
- 3.1 – Random quitting bug that occurs when Celtic3/DCS7 hook disabled traced to DCS/Celtic3 itself.
- 3.2 – Zeroes finding algorithm no longer fails if last terms in polynomial are zero. Realizing that trailing zeroes mean some power of X is factorable, 0 is added as a zero and the trailing zeroes are dropped. Rational zeroes test as normal.

## **Contact Me**

Have a question? Comment? Complaint? Feature request? Bug report? Shoot me an email at [ac@clrh.org](mailto:ac@clrh.org). You can also find me on Facebook at <http://facebook.com/acagliano/> and on Twitter at <http://twitter.com/ACagliano/>.