

# Teaching Calculus with the TI-89

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## Getting acquainted:

- TI-83: “think green”
- The Computer Algebra System
- **F6**: NewProb
- ‘by hand’ Algebra
- Close all parentheses ()
- **F2**: Algebra
- **F3**: Calculus
- Use **CATALOG** for *syntax hints*
- Use the **History**
- Editing includes *select, cut, copy, paste, Home, End*
- Save your **Homework!**
- Organize your files

## Warm-up:

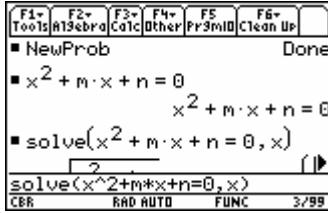
Find, in terms of  $m$  and  $n$ , the sum of the reciprocals of the roots of  $x^2 + mx + n = 0$

## Web Resources:

- John Hanna: <http://www.johnhanna.us>  
see ‘calculators’
- TI Education: <http://education.ti.com>  
see **Activities Exchange**
- T<sup>3</sup> • Teachers Teaching with Technology  
see TI Education, Professional Development

## Step-by-Step

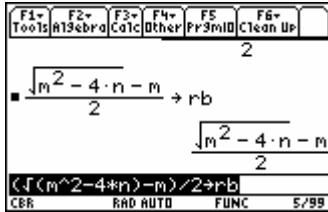
1. Find, in terms of  $m$  and  $n$ , the sum of the reciprocals of the roots of  $x^2 + mx + n = 0$



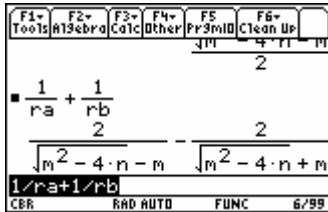
First, start a “NewProb” ([F6] 2:)

Enter the equation to solve (*for later use*)

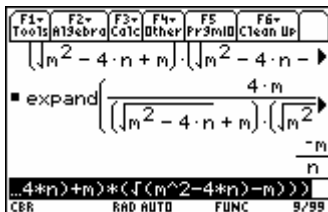
Use [F2]: **solve**( to solve for  $x$ : First, put the command down, then go up (⊖) and retrieve (ENTER) the equation, then type a ‘comma’ and the letter  $x$ , close parentheses, and press [ENTER] to evaluate the command.



Use copy and editing tools to store the two roots in the variables  $ra$  and  $rb$ . Follow the presenter!



Evaluate  $1/ra + 1/rb$ . Look good? (NO), but it IS right.



Use [F2]: **expand**( and [F2]: **comDemon**( to simplify the expression. First, put the command down, then go up (⊖) and retrieve (ENTER) the last result, then press [ENTER] to evaluate.

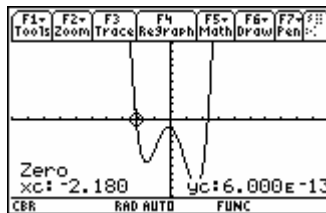
2. Solve for  $x$  to the nearest hundredth:  $x^{-1} + x^{-2} = x^2 - 5$

TI-84 Plus calculator screen showing the equation  $x^{-1} + x^{-2} = x^2 - 5$  and the solve function being entered:  $\text{solve}\left(\frac{1}{x} + \frac{1}{x^2} = x^2 - 5, x\right)$ . The screen also shows the command  $\text{solve}(1/x+1/x^2=x^2-5,x)$  and the status bar with CBR, RAD AUTO, FUNC, and 3/3.

TI-84 Plus calculator screen showing the solution  $x = 2.367$  or  $x = -2.180$ . The screen also shows the command  $\text{solve}(1/x+1/x^2=x^2-5,x)$  and the status bar with CBR, RAD AUTO, FUNC, and 3/99.

Or (the “traditional” (!!)) method) ...

TI-84 Plus calculator screen showing the equation  $y_1 = x^4 - 5x^2 - x - 1$ . The screen also shows the command  $y_2(x) =$  and the status bar with CBR, RAD AUTO, FUNC.



## Calculus Topics

### Limits:

Limit(expression, independent var, value, optional direction)

$$\text{Limit}(\sin(x)/x, x, 0, 1) \quad \rightarrow \quad \lim_{x \rightarrow 0^+} \frac{\sin(x)}{x}$$

### Definition of the Derivative

Define  $\text{der}(x) = \text{limit}((f(x+h) - f(x))/h, h, 0)$

### Applications of the Derivative: Related Rates and Optimization

**RR:** Sand is falling into a conical pile at the rate of  $100\text{ft}^3/\text{min}$ . The diameter of the base is 4\*height. How fast is the height changing when the pile is 10ft high?

```
define v(t) = 1/3*pi*r(t)^2*h(t)
define r(t) = 2*h(t)
d(v(t),t) -> dvdt
dvdt/d(h(t),t) = dhdt -> dvdt
solve(dvdt=100,dhdt)-> dhdt
dhdt|h(t)=10
```

Answer:  $1/4\pi$

**OPT:** see **Volume of a Can**

### Implicit Differentiation

The secret... write  $y(x)$  instead of  $y$ ...

Given  $x+y^2 = 2x^2y + 1$ , find  $dy/dx$ .

Enter:  $x+y(x)^2 = 2x^2*y(x) \rightarrow \text{eq}$

**d(eq,x)**

In resulting equation, replace  $d(y(x), x)$  with  $dydx$ .

Solve for  $dydx$ .

### Reimann Sums (programs)

#### Definition of the Definite Integral

```
define f(x) = x^2
```

```
define Integral(f(x),x,a,b) = limit(sum(      ),i,1,n),n, inf)
```

## Managing your work: Folders and files

To make a folder:

- Press VAR-LINK (2nd[-])
- Press [F1] Manage, and choose **5: Create Folder**
- Enter a 'legal' folder name and press [ENTER]

To make a folder the 'active' folder:

- Press [MODE],
- Go down to the '**Current Folder...**' setting,
- Press ⏴ to see the list of folders to choose from.
- Press [ENTER] to choose it and
- Press [ENTER] again to save the mode settings.

To 'Save your HOME work':

- On the HOME screen, press [F1] **Tools**
- Choose **2: Save Copy As...**
- If you like,
  - choose a different folder by pressing ⏴ and choosing one from the list.
- Press ⏵ to go down to the filename textbox and
- Type a 'legal' filename.
- Press [ENTER] to enter it and
- Press [ENTER] again to save and close the dialog box.

To retrieve and use your saved HOME work:

- Use the Text Editor App to open your saved file (Press [APPS]).
- Feel free to edit the file (add notes).
- A horizontal split screen with the text file on top and the HOME screen on bottom looks best: use the [MODE] screen to set it up.
- Execute C: command lines: Press [F4] on each line.

## Miscellaneous screens

1

F1+	F2+	F3+	F4+	F5	F6+
Tools	Algebra	Calc	Other	Pr3mid	Clean Up
■	NewProb			Done	
■	factor(74)			2·37	
■	factor(54)			2·3 <sup>3</sup>	
■	1·2·27·37			1998	
CALCULUS RAD AUTO FUNC 4/30					

Numerical

2

F1+	F2+	F3+	F4+	F5	F6+
Tools	Algebra	Calc	Other	Pr3mid	Clean Up
■	$h = \frac{200}{\pi \cdot r^2} \mid r = \frac{10^{2/3}}{\pi^{1/3}}$				
	$h = \frac{2 \cdot 10^{2/3}}{\pi^{1/3}}$				
CALCULUS RAD AUTO FUNC 7/30					

Volume of a can

3

F1+	F2+	F3+	F4+	F5	F6+
Tools	Algebra	Calc	Other	Pr3mid	Clean Up
■	NewProb			Done	
■	$\frac{1}{\sqrt{2}}$			$\frac{\sqrt{2}}{2}$	
■	$\sqrt{16+28}$			$2\sqrt{11}$	
■	$\pi \cdot 6^2$			$36 \cdot \pi$	
CALCULUS RAD AUTO FUNC 4/30					

Symbolic answers

4

F1+	F2+	F3+	F4+	F5+	F6+	F7+
Tools	Zoom	Edit	All	Style	Plot	...
*PLOTS						
Plot 2:						
Plot 1:						
√y1=	$5 - x^2, x \leq 1$					
	$x + 2, \text{else}$					
y2=	$x^2 - 1$					
y3=						
y1(x)=when(x≤1,5-x^2,x+2)						
CALCULUS RAD AUTO FUNC						

Piecewise graphing

5

F1+	F2+	F3+	F4+	F5
Tools	Command	View	Execute	Find...
■	1998 AB-1			
C:	NewProb			
■	a)			
C:	$f(\sqrt{x}, x, 0, 4)$			
■	b)			
C:	$\text{solve}(f(\sqrt{x}, x, 0, h)=8/3,$			
h)				
■	c)			
C:	$f(\pi * (\sqrt{x})^2, x, 0, 4)$			
CALCULUS RAD AUTO FUNC				

Scripting

6

F1+	F2+	F3	F4+	F5+	F6+	F7+
Tools	Zoom	Tracs	ReGraph	Math	Draw	Pen
[Graph showing two functions plotted on a coordinate plane]						
CALCULUS RAD AUTO G1 FUNC						

Two graphs

7

F1+	F2+	F3+	F4+	F5
Tools	Command	View	Execute	Find...
■	$\tan^{-1}(\infty)$			
■	$\ln(0)$			
■	$e^{-(-\infty)}$			
■	$i^{-67}$			
■	$\sqrt{-1}$			
■	$\sqrt{-i}$			
■	$e^{(i\pi)}$			
■	$\sin^{-1}(-2)$			
■	$(-8)^{(2/3)}$			
CALCULUS RAD AUTO FUNC				

Special numbers

8

F1+	F2+	F3+	F4+	F5	F6+
Tools	Algebra	Calc	Other	Pr3mid	Clean Up
■	NewProb			Done	
■	$3 \cdot x + 5 \cdot x$			$8 \cdot x$	
■	$3 \cdot x + 5 \cdot x \mid x = 3$			24	
■	$3 \cdot x + 5 \cdot x$			$8 \cdot x$	
■	$3 \cdot x + 5 \cdot x \mid x = a$			$8 \cdot a$	
$3x+5x \mid x=F$					
CALCULUS RAD AUTO FUNC 5/30					

"simple" algebra

9

F1+	F2+	F3+	F4+	F5	F6+
Tools	Algebra	Calc	Other	Pr3mid	Clean Up
■	$\text{factor}(x^4 + x^2 - 12)$				
	$(x^2 - 3) \cdot (x^2 + 4)$				
■	$\text{factor}(x^4 + x^2 - 12, x)$				
	$(x + \sqrt{3}) \cdot (x - \sqrt{3}) \cdot (x^2 + 4)$				
$\text{factor}(x^4 + x^2 - 12, x)$					
CALCULUS RAD AUTO FUNC 3/30					

"better" algebra

10

F1+	F2+	F3+	F4+	F5	F6+
Tools	Algebra	Calc	Other	Pr3mid	Clean Up
■	$\text{expand}((x - 5)^5)$				
	$x^5 - 25 \cdot x^4 + 250 \cdot x^3 - 1250 \cdot x^2 + 3125 \cdot x - 3125$				
■	$\text{expand}((\sqrt{x - 1} + 2)^2)$				
	$4 \cdot \sqrt{x - 1} + x + 3$				
CALCULUS RAD AUTO FUNC 3/30					

More cool algebra tools

11

F1+	F2+	F3+	F4+	F5
Tools	Command	View	Execute	Find...
■	solve...			
■	$3x - 2y = 7$			
■	$4x + 5y = 18$			
■	$\text{solve}(3x - 2y = 7, x)$			
■	$\text{solve}(4x + 5y = 18, y) \mid x = \dots$			
■	$x = \dots \mid y = \dots$			
CALCULUS RAD AUTO FUNC				

Simultaneous equations

12

F1+	F2+	F3+	F4+	F5	F6+
Tools	Algebra	Calc	Other	Pr3mid	Clean Up
■	Define $\sec(xx) = \frac{1}{\cos(xx)}$			Done	
■	$\sec\left(\frac{\pi}{6}\right)$			$\frac{2\sqrt{3}}{3}$	
HANNA RAD AUTO FUNC 2/30					

Defining functions

**Volume of a can:**

A tin can is to be constructed in the shape of a cylinder and is to hold 1 liter of soup. Determine the dimensions of the can (radius and height) that minimize the surface area of the cylinder.

**NewProb**

**Define** the formula for the Surface Area of a cylinder (the function to minimize, in terms of  $h$  and  $r$ ).

Enter the *equation* for the Volume of the cylinder.

**Solve** the Volume *equation* for  $h$ .

Now replace the  $h$  in the Surface Area function with its equivalent expression in terms of  $r$ .

Next...?

*do the math*

**Prime?**

Fermat proposed that  $F(x) = 2^{(2^x)} + 1$  is *prime* when  $x$  is a Natural number. What is the first value of  $x$  for which this conjecture fails?

**Fun stuff**

What is the square root of **12345678987654321**?

What is the slope of  $y=|x^x|$  at  $(0, 1)$ ?

Find the area of the largest rectangle that has one side on the positive  $x$ -axis and the other two vertices on the function  $y=xe^{-x}$