MathCAD Homework

by First_name Last_name
MM/DD/YY

Basic calculations (solution to quadratic equation: $ax^2 + bx + c = 0$)

$a := 1 \qquad b := 2 \qquad c := 3$

$$x_1 := \frac{-b + \sqrt{b^2 - 4 \cdot a \cdot c}}{2 \cdot a} \qquad x_2 := \frac{-b - \sqrt{b^2 - 4 \cdot a \cdot c}}{2 \cdot a}$$

$x_1 = -1 + 1.414i \qquad x_2 = -1 - 1.414i$

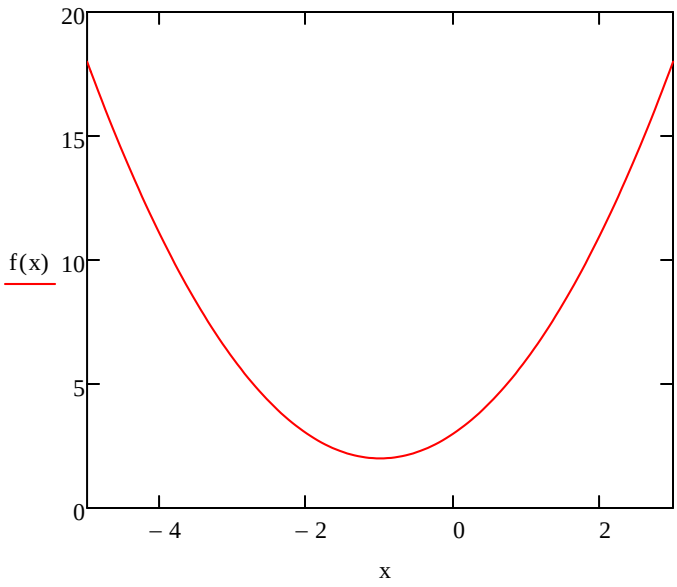
checking results:

$f(x) := a \cdot x^2 + b \cdot x + c$

$f(x_1) = 0 \qquad f(x_2) = 0$

Plotting a function using a range variable

$x := -5, -4.95 .. 3$



x =

-5
-4.95
-4.9
-4.85
-4.8
-4.75
-4.7
-4.65
-4.6
-4.55
-4.5
-4.45
-4.4
-4.35
-4.3
...

Using units and significant digit display

$m := 100 \cdot lb \qquad v := 60 \cdot mph \qquad a := 20 \cdot \frac{ft}{sec^2}$

$p := m \cdot v \qquad p = 1.217 \times 10^3 \frac{m \cdot kg}{s}$

$F := m \cdot a \qquad F = 62.2 \cdot lbf$

Symbolic Algebra

$$\frac{x}{2x - 3\cdot x\cdot y} = \frac{(x-2)^2}{(y+2)}$$

$$x(y) := \begin{bmatrix} \dfrac{6\cdot y + \sqrt{-(y+2)\cdot(3\cdot y - 2)} - 4}{3\cdot y - 2} \\ -\dfrac{\sqrt{-(y+2)\cdot(3\cdot y - 2)} - 6\cdot y + 4}{3\cdot y - 2} \end{bmatrix}$$

$x(5)_0 = 2 + 0.734i \qquad x(5)_1 = 2 - 0.734i$

Symbolic Calculus

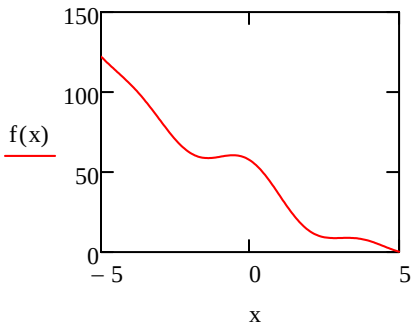
$a := 6.1$

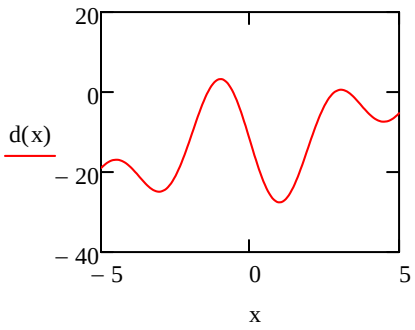
redefine "a" to be unitless (see above), so MathCAD is not confused below.

$$f(x) := (x-a)^2 + \frac{10\sin(2\cdot x)}{x}$$

$$d(x) := 2\cdot x - 2\cdot a + \frac{20\cdot\cos(2\cdot x)}{x} - \frac{10\cdot\sin(2\cdot x)}{x^2}$$

$x := -5, -4.95 .. 5$





Vector and Matrix Calculations

$v_x := -1 \qquad v_y := -2$

$v := \begin{pmatrix} v_x \\ v_y \end{pmatrix} \qquad v = \begin{pmatrix} -1 \\ -2 \end{pmatrix}$

$|v| = 2.236 \qquad v \cdot v = 5$ magnitude and dot product

$v := v_x + i \cdot v_y$ complex plane representation

$\arg(v) = -116.565 \cdot \text{deg}$ angle to a vector (argument)

$A := \begin{pmatrix} 1 & 2 & 3 \\ 2 & 1 & 5 \\ 0 & -2 & 3 \end{pmatrix} \qquad A^{-1} = \begin{pmatrix} -1.182 & 1.091 & -0.636 \\ 0.545 & -0.273 & -0.091 \\ 0.364 & -0.182 & 0.273 \end{pmatrix}$

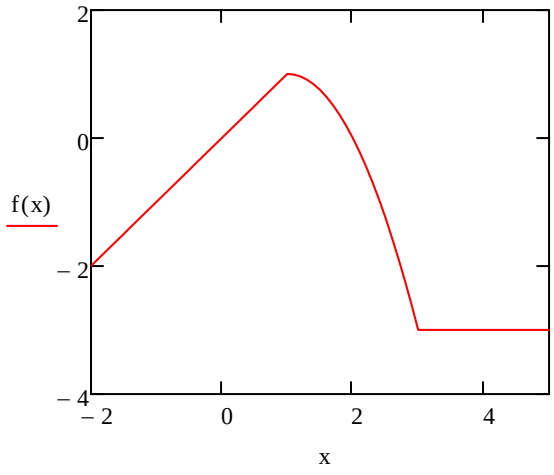
$A \cdot A^{-1} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

Programming

$$f(x) := \begin{cases} x & \text{if } x < 1 \\ \left[-(x-1)^2 + 1\right] & \text{if } 1 \le x \le 3 \\ (-3) & \text{if } x > 3 \end{cases}$$

piecewise function

$x := -2, -1.9 .. 5$



general programming problem example: find the sum of first N numbers divisible by 3

$N := 10000$

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results := | i ← 0
           | n ← 0
           | total ← 0
           | while n < N
           |     i ← i + 1
           |     remainder ← mod(i, 3)
           |     total ← total + | i  if remainder = 0
           |                     | 0  otherwise
           |     n ← n + 1  if remainder = 0
           | (i  total)
```

$results = \begin{pmatrix} 3 \times 10^4 & 1.5 \times 10^8 \end{pmatrix}$ $largest := results_{0,0}$ $largest = 3 \times 10^4$

$sum := results_{0,1}$ $sum = 1.5 \times 10^8$

alternative solution (for this problem)

$i := 3, 6 .. 3 \cdot N$ $sum := \sum_i i$ $sum = 1.5 \times 10^8$

other (even better) alternative solutions (for this problem):

$3 \cdot \sum_{i=1}^{N} i = 1.5 \times 10^8$ or $3 \frac{N \cdot (N+1)}{2} = 1.5 \times 10^8$

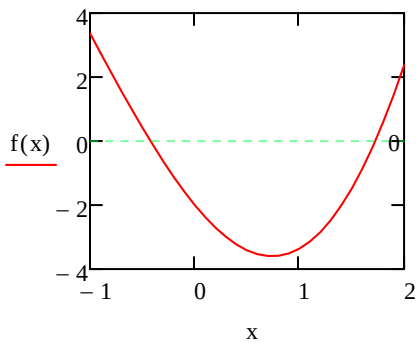
Finding roots

$f(x) := 2 \cdot x^2 - 4 \cdot \sin(x) - 2$

$x := 1$ $root(f(x), x) = 1.725$

$x := -1$ $root(f(x), x) = -0.423$

$x := -1, -0.9 .. 2$



marker added at 0 on vertical axis

Solving a set of nonlinear equations

$x := 1 \qquad y := 1$ initial guess

Given

$$x = 2 - y^2$$

$$y = \frac{\sin(x)}{x} + x \cdot y$$

$solution := Find(x, y)$

$x := solution_0 \qquad x = 0.252 \qquad y := solution_1 \qquad y = 1.322$

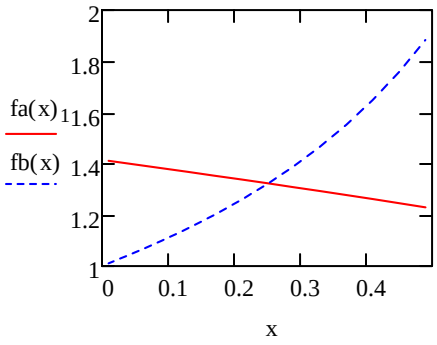
Checking results (solving symbolically and plotting)

$$x = 2 - y^2 \qquad y = \frac{\sin(x)}{x} + x \cdot y$$

$$fa(x) := \begin{pmatrix} \sqrt{x - 2} \cdot i \\ -\sqrt{x - 2} \cdot i \end{pmatrix} \qquad fb(x) := -\frac{\sin(x)}{x \cdot (x - 1)}$$

$fa(x)_1 = 1.322 \qquad fb(x) = 1.322$

$x := 0.01, 0.05 .. 0.5$



Iterative calculations with subscripts

$i := 1 .. 10 \qquad x_0 := 1 \qquad y_0 := 1$

$$x_i := x_{i-1} + 2$$

$$y_i := \frac{x_{i-1} + x_i}{2}$$

$x =$

	0
0	1
1	3
2	5
3	7
4	9
5	11
6	13
7	...

$y =$

	0
0	1
1	2
2	4
3	6
4	8
5	10
6	12
7	...

Finding an optimal solution given constraints

$x := 1 \qquad y := 1$

$z(x, y) := (x - 1)^2 - x \sin(y)$

Given

$x > -2$

$x < 2 \cdot y^2 + 3$

$-3 < y < 5$

$z\_max\_loc := \text{Maximize}(z, x, y)$

$$z\_max\_loc = \begin{pmatrix} -2 \\ 1.571 \end{pmatrix}$$

$x := z\_max\_loc_0 \qquad x = -2$

$y := z\_max\_loc_1 \qquad y = 1.571 \qquad z(x, y) = 11$