

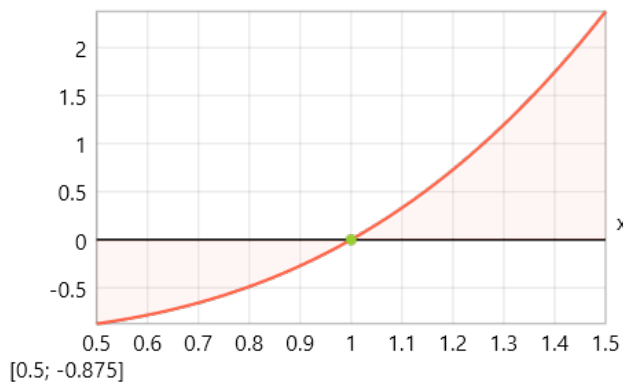
Root-finding Test Functions

Sérgio Galdino. *A family of regula falsi root-finding methods*. Proceedings of 2011 World Congress on Engineering and Technology. Shanghai, China. IEEE Press. ISBN 978-1-61284-365-0. p. 514-517

<http://sergiogaldino.pbworks.com/w/file/fetch/66011429/0130-1943543>

$$f_{01}(x) = x^3 - 1$$

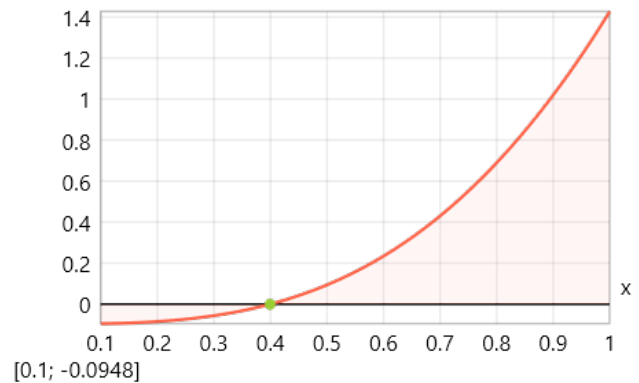
[1.5; 2.38]



$$x_{01} = \text{\$Root} \{ f_{01}(x) = 0; x \in [0.5; 1.5] \} = 1$$

$$f_{02}(x) = x^2 \cdot \left(\frac{x^2}{3} + \sqrt{2} \cdot \sin(x) \right) - \frac{\sqrt{3}}{18}$$

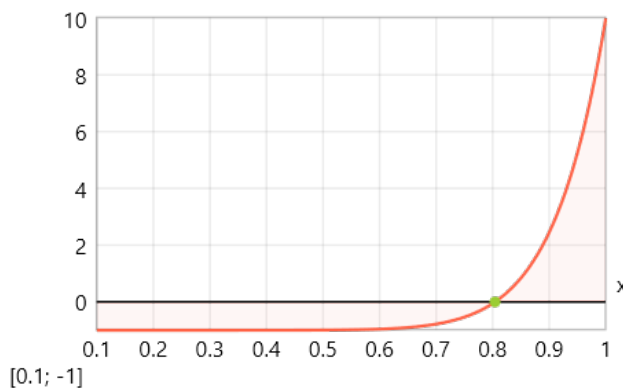
[1; 1.43]



$$x_{02} = \text{\$Root} \{ f_{02}(x) = 0; x \in [0.1; 1] \} = 0.399$$

$$f_{03}(x) = 11 \cdot x^{11} - 1$$

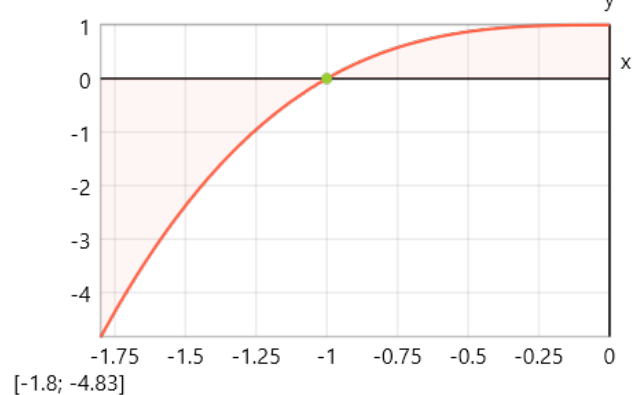
[1; 10]



$$x_{03} = \text{\$Root} \{ f_{03}(x) = 0; x \in [0.1; 1] \} = 0.804$$

$$f_{04}(x) = x^3 + 1$$

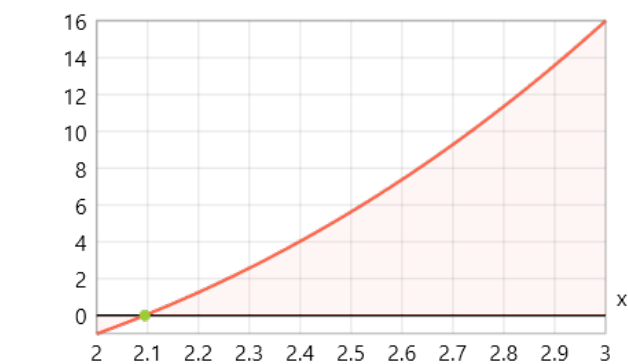
[-1.58E-14; 1]



$$x_{04} = \text{\$Root} \{ f_{04}(x) = 0; x \in [-1.8; 0] \} = -1$$

$$f_{05}(x) = x^3 - 2 \cdot x - 5$$

[3; 16]

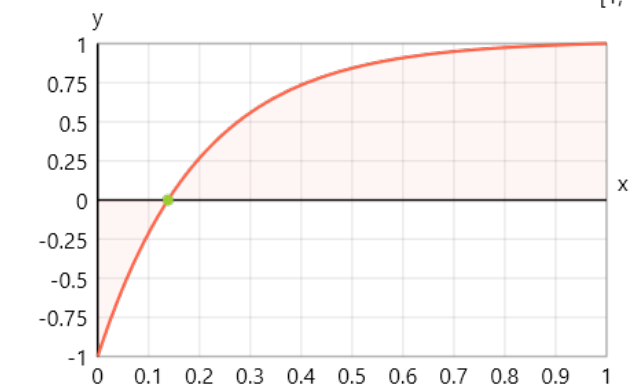


[2; -1]

$$x_{05} = \text{\$Root} \{ f_{05}(x) = 0; x \in [2; 3] \} = 2.09$$

$$f_{06}(x) = 2 \cdot x \cdot e^{-5} + 1 - 2 \cdot e^{-5 \cdot x}$$

[1; 1]

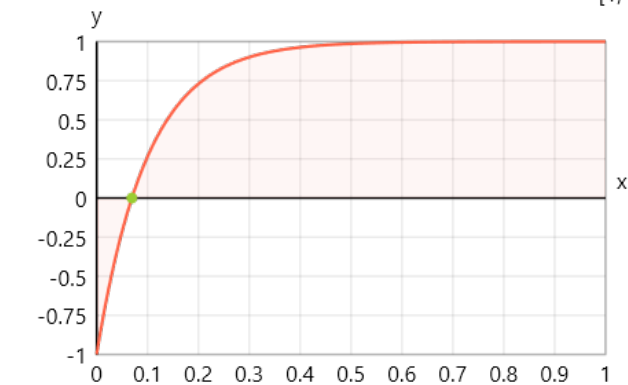


[0; -1]

$$x_{06} = \text{\$Root} \{ f_{06}(x) = 0; x \in [0; 1] \} = 0.138$$

$$f_{07}(x) = 2 \cdot x \cdot e^{-10} + 1 - 2 \cdot e^{-10 \cdot x}$$

[1; 1]

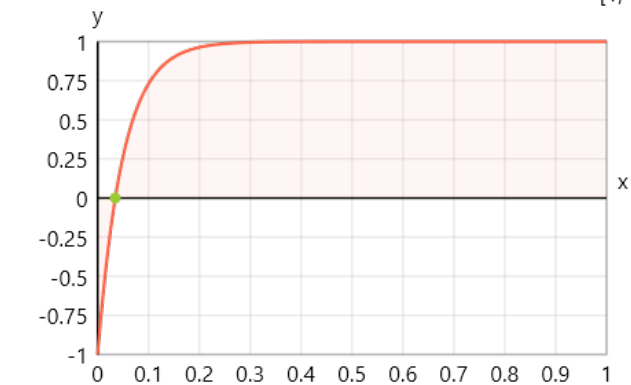


[0; -1]

$$x_{07} = \text{\$Root} \{ f_{07}(x) = 0; x \in [0; 1] \} = 0.0693$$

$$f_{08}(x) = 2 \cdot x \cdot e^{-20} + 1 - 2 \cdot e^{-20 \cdot x}$$

[1; 1]

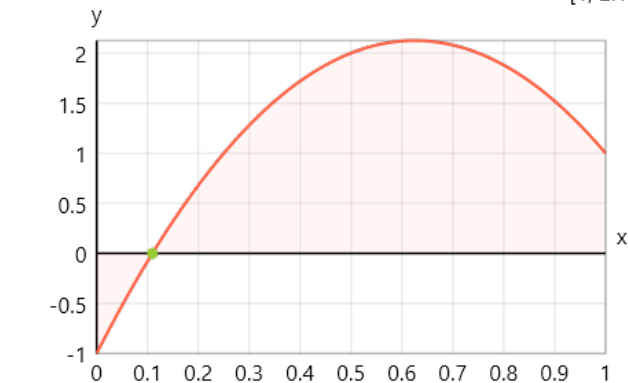


[0; -1]

$$x_{08} = \text{\$Root} \{ f_{08}(x) = 0; x \in [0; 1] \} = 0.0347$$

$$f_{09}(x) = (1 + (1 - 5)^2) \cdot x^2 - (1 - 5 \cdot x)^2$$

[1; 2.12]

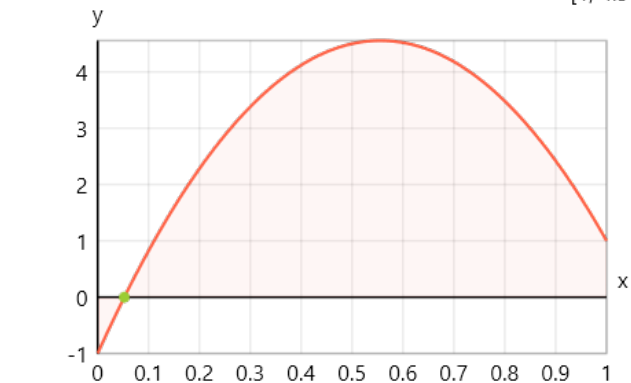


[0; -1]

$$x_{09} = \text{\$Root} \{ f_{09}(x) = 0; x \in [0; 1] \} = 0.11$$

$$f_{10}(x) = (1 + (1 - 10)^2) \cdot x^2 - (1 - 10 \cdot x)^2$$

[1; 4.56]

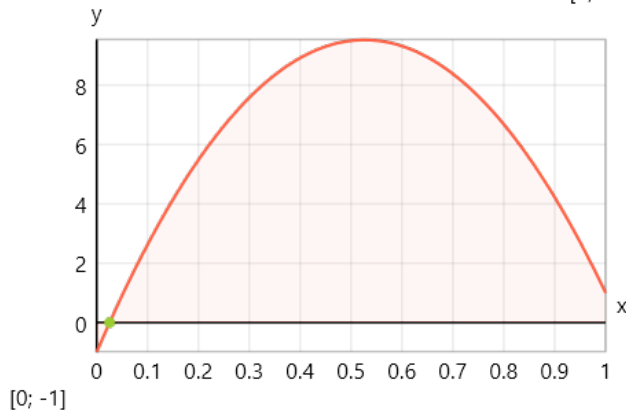


[0; -1]

$$x_{10} = \text{\$Root} \{ f_{10}(x) = 0; x \in [0; 1] \} = 0.0525$$

$$f_{11}(x) = (1 + (1 - 20)^2) \cdot x^2 - (1 - 20 \cdot x)^2$$

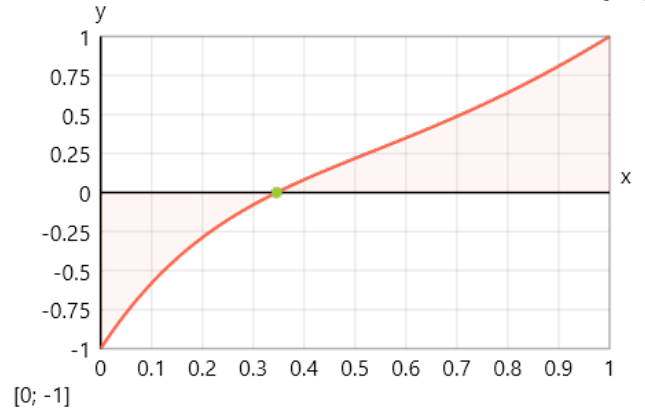
[1; 9.53]



$$x_{11} = \text{\$Root}\{f_{11}(x) = 0; x \in [0; 1]\} = 0.0256$$

$$f_{12}(x) = x^2 - (1 - x)^5$$

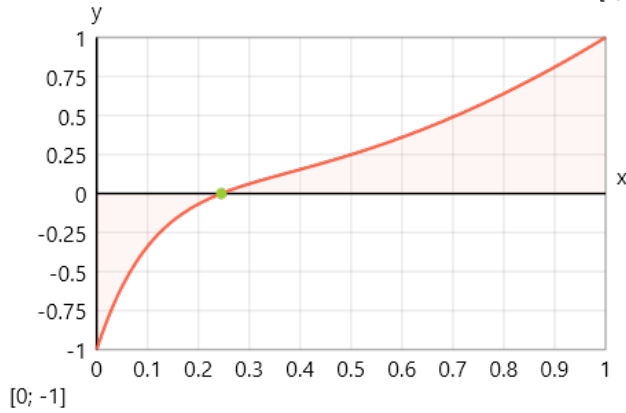
[1; 1]



$$x_{12} = \text{\$Root}\{f_{12}(x) = 0; x \in [0; 1]\} = 0.346$$

$$f_{13}(x) = x^2 - (1 - x)^{10}$$

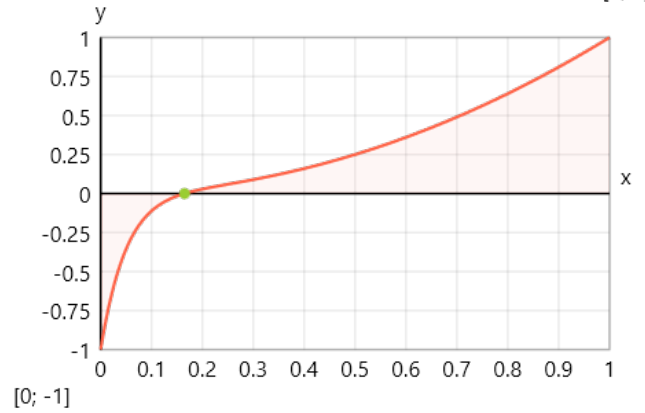
[1; 1]



$$x_{13} = \text{\$Root}\{f_{13}(x) = 0; x \in [0; 1]\} = 0.245$$

$$f_{14}(x) = x^2 - (1 - x)^{20}$$

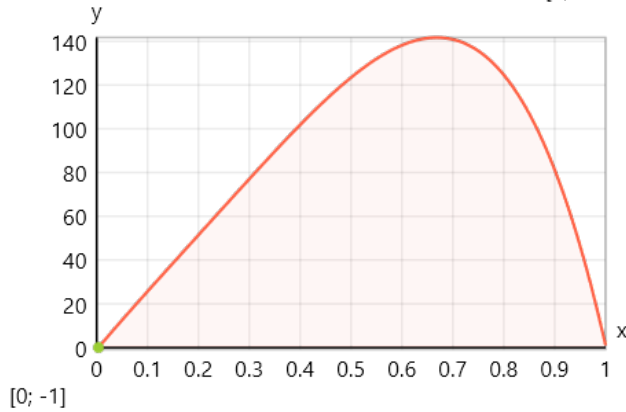
[1; 1]



$$x_{14} = \text{\$Root}\{f_{14}(x) = 0; x \in [0; 1]\} = 0.165$$

$$f_{15}(x) = (1 + (1 - 5)^4) \cdot x - (1 - 5 \cdot x)^4$$

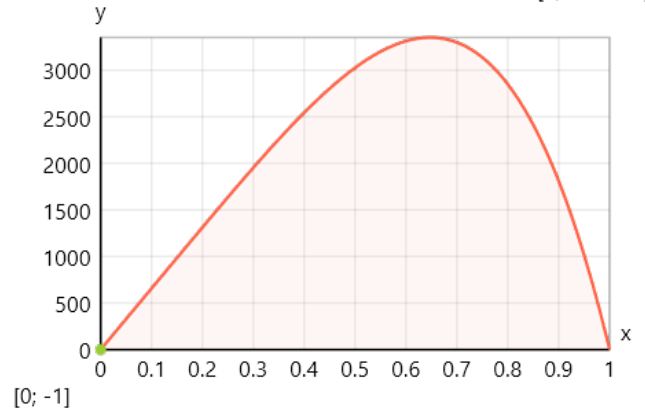
[1; 141.69]



$$x_{15} = \text{\$Root}\{f_{15}(x) = 0; x \in [0; 1]\} = 0.00362$$

$$f_{16}(x) = (1 + (1 - 10)^4) \cdot x - (1 - 10 \cdot x)^4$$

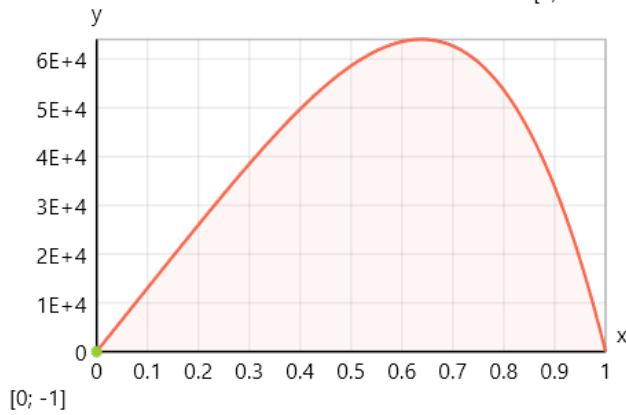
[1; 3350.34]



$$x_{16} = \text{\$Root}\{f_{16}(x) = 0; x \in [0; 1]\} = 0.000151$$

$$f_{17}(x) = (1 + (1 - 20)^4) \cdot x - (1 - 20 \cdot x)^4$$

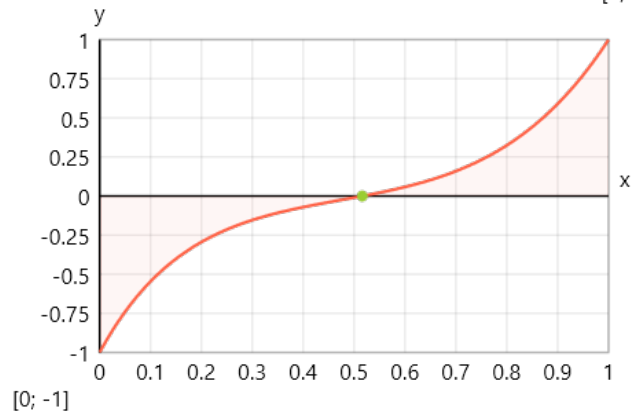
[1; 64019.2]



$$x_{17} = \text{\$Root}\{f_{17}(x)=0; x \in [0; 1]\} = 7.67 \times 10^{-6}$$

$$f_{18}(x) = e^{-5 \cdot x} \cdot (x - 1) + x^5$$

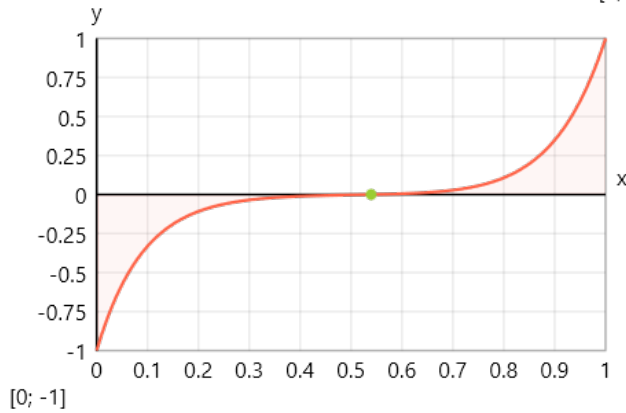
[1; 1]



$$x_{18} = \text{\$Root}\{f_{18}(x)=0; x \in [0; 1]\} = 0.516$$

$$f_{19}(x) = e^{-10 \cdot x} \cdot (x - 1) + x^{10}$$

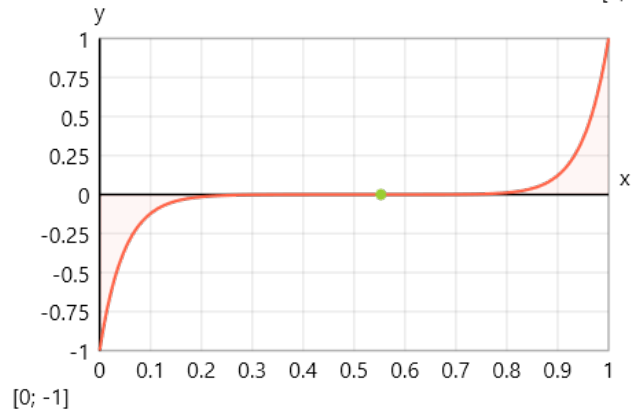
[1; 1]



$$x_{19} = \text{\$Root}\{f_{19}(x)=0; x \in [0; 1]\} = 0.54$$

$$f_{20}(x) = e^{-20 \cdot x} \cdot (x - 1) + x^{20}$$

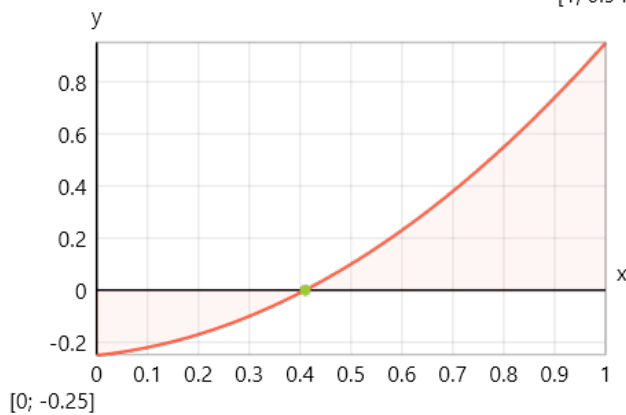
[1; 1]



$$x_{20} = \text{\$Root}\{f_{20}(x)=0; x \in [0; 1]\} = 0.553$$

$$f_{21}(x) = x^2 + \sin\left(\frac{x}{5}\right) - \frac{1}{4}$$

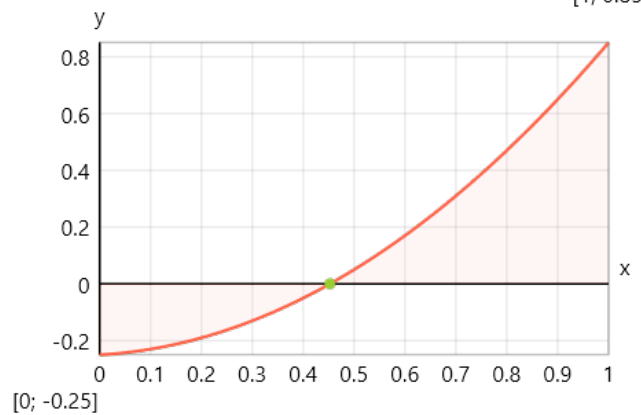
[1; 0.949]



$$x_{21} = \text{\$Root}\{f_{21}(x)=0; x \in [0; 1]\} = 0.41$$

$$f_{22}(x) = x^2 + \sin\left(\frac{x}{10}\right) - \frac{1}{4}$$

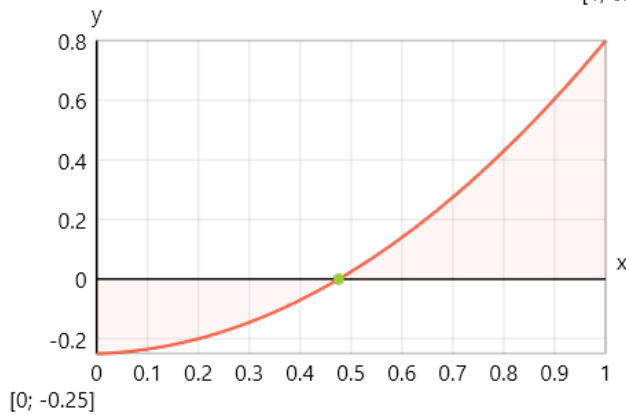
[1; 0.85]



$$x_{22} = \text{\$Root}\{f_{22}(x)=0; x \in [0; 1]\} = 0.453$$

$$f_{23}(x) = x^2 + \sin\left(\frac{x}{20}\right) - \frac{1}{4}$$

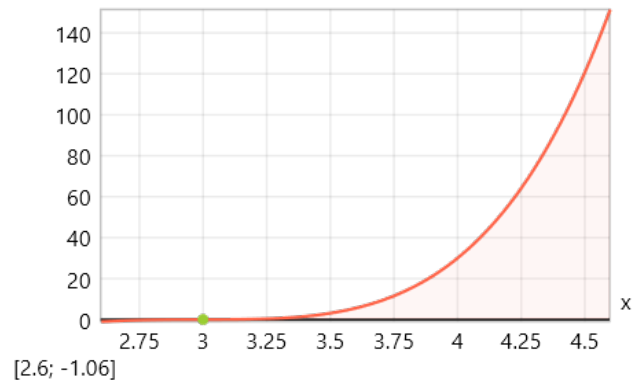
[1; 0.8]



$$x_{23} = \text{\$Root}\{f_{23}(x) = 0; x \in [0; 1]\} = 0.476$$

$$f_{24}(x) = (x+2) \cdot (x+1) \cdot (x-3)^3$$

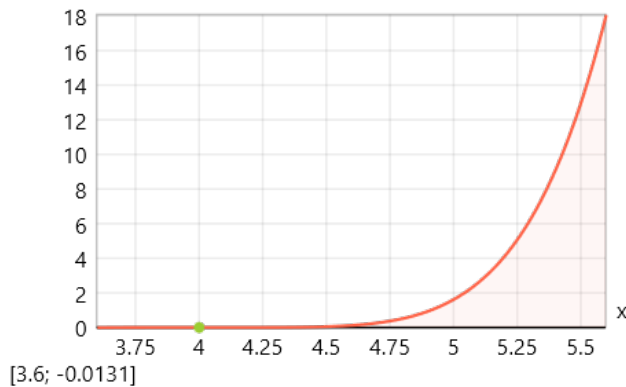
[4.6; 151.39]



$$x_{24} = \text{\$Root}\{f_{24}(x) = 0; x \in [2.6; 4.6]\} = 3$$

$$f_{25}(x) = (x-4)^5 \cdot \ln(x)$$

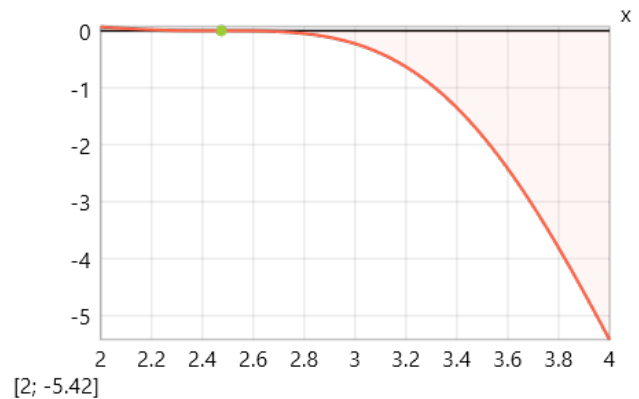
[5.6; 18.06]



$$x_{25} = \text{\$Root}\{f_{25}(x) = 0; x \in [3.6; 5.6]\} = 4$$

$$f_{26}(x) = \left(\sin(x) - \frac{x}{4}\right)^3$$

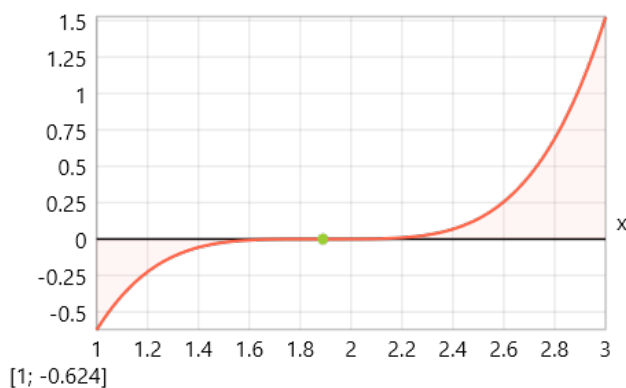
[4; 0.0686]



$$x_{26} = \text{\$Root}\{f_{26}(x) = 0; x \in [2; 4]\} = 2.47$$

$$f_{27}(x) = (81 - p(x) \cdot (108 - p(x) \cdot (54 - p(x) \cdot (12 - p(x)) \cdot (\text{sign}(p(x) - 3))), p(x) = x + 1.11$$

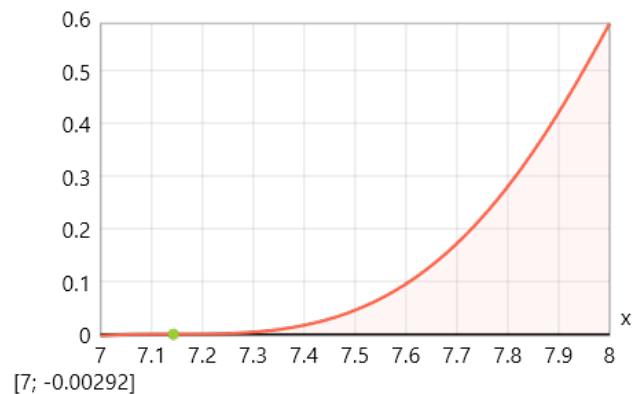
[3; 1.52]



$$x_{27} = \text{\$Root}\{f_{27}(x) = 0; x \in [1; 3]\} = 1.89$$

$$f_{28}(x) = \sin((x - 7.14)^3)$$

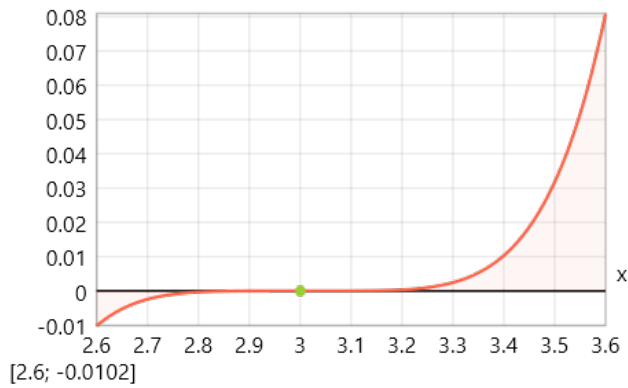
[8; 0.589]



$$x_{28} = \text{\$Root}\{f_{28}(x) = 0; x \in [7; 8]\} = 7.14$$

$$f_{29}(x) = e^{(x-3)^5} - 1$$

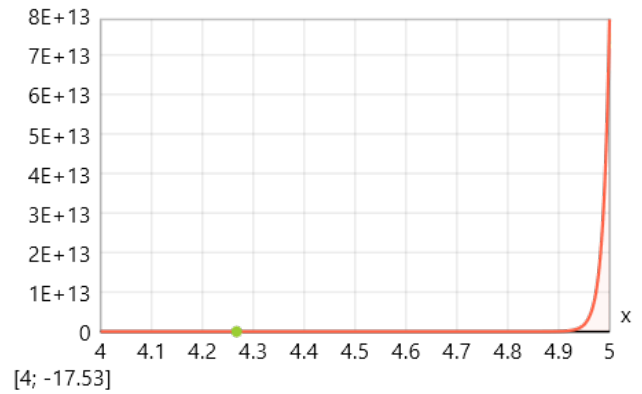
[3.6; 0.0809]



$$x_{29} = \$Root \{ f_{29}(x) = 0 ; x \in [2.6 ; 3.6] \} = 3$$

$$f_{30}(x) = e^{(x-3)^5} - e^{x-1}$$

[5; 78962960182626]

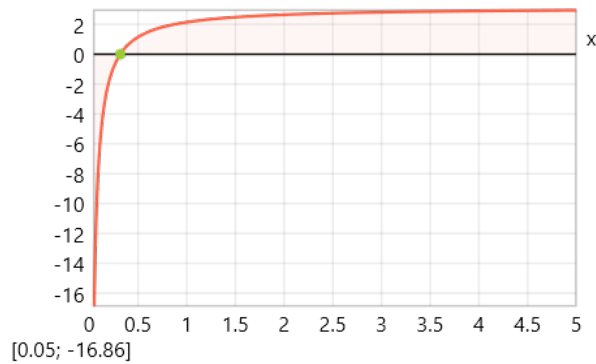


$$x_{30} = \$Root \{ f_{30}(x) = 0 ; x \in [4 ; 5] \} = 4.27$$

My functions

$$f_{31}(x) = \pi - \frac{1}{x}$$

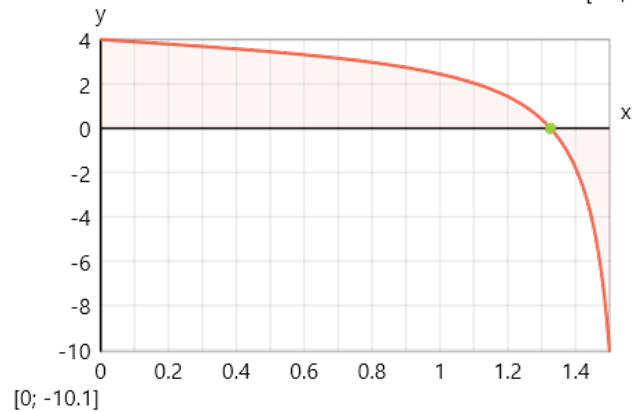
[5; 2.94]



$$x_{31} = \$Root \{ f_{31}(x) = 0 ; x \in [0.05 ; 5] \} = 0.318$$

$$f_{32}(x) = 4 - \tan(x)$$

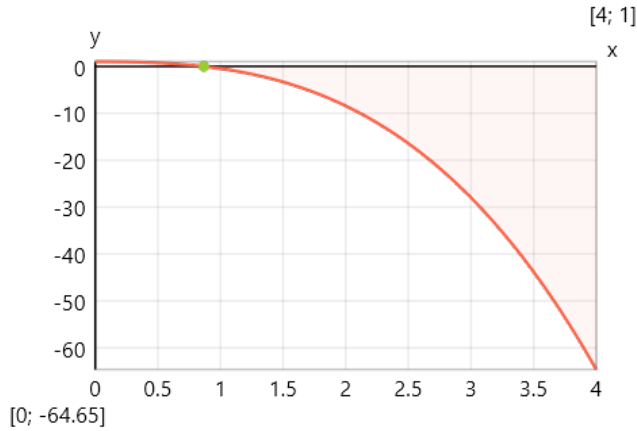
[1.5; 4]



$$x_{32} = \$Root \{ f_{32}(x) = 0 ; x \in [0 ; 1.5] \} = 1.33$$

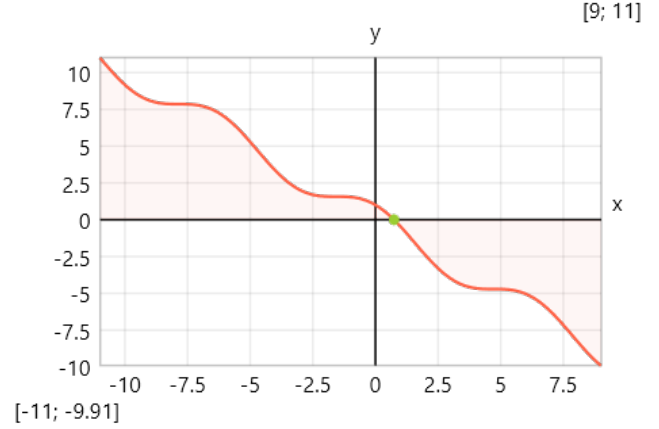
Steven A. Stage. *Comments on An Improvement to the Brent's Method*. International Journal of Experimental Algorithms (IJEAl), Volume (4) : Issue (1) : 2013

$$f_{33}(x) = \cos(x) - x^3$$



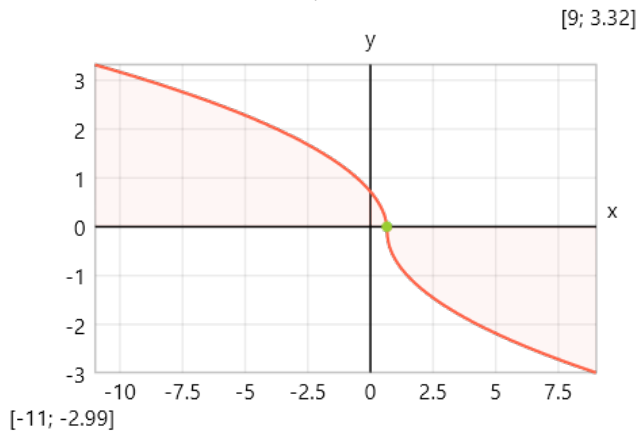
$$x_{33} = \$Root\{f_{33}(x) = 0; x \in [0; 4]\} = 0.865$$

$$f_{34}(x) = \cos(x) - x$$



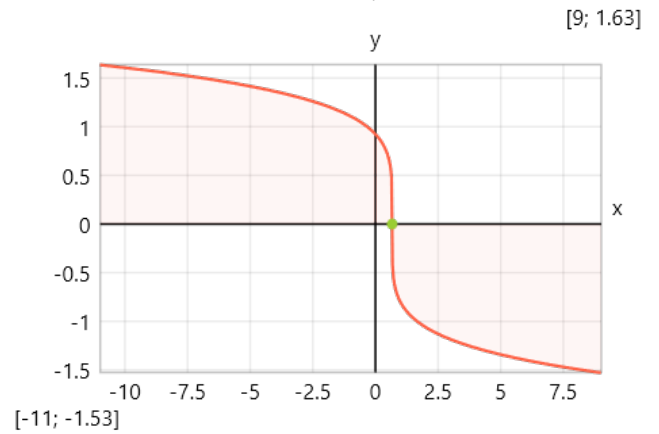
$$x_{34} = \$Root\{f_{34}(x) = 0; x \in [-11; 9]\} = 0.739$$

$$f_{35}(x) = \sqrt{\left|x - \frac{2}{3}\right|} \cdot \begin{cases} \text{if } x \leq \frac{2}{3}: & 1 \\ \text{else:} & -1 \end{cases} - 0.1$$



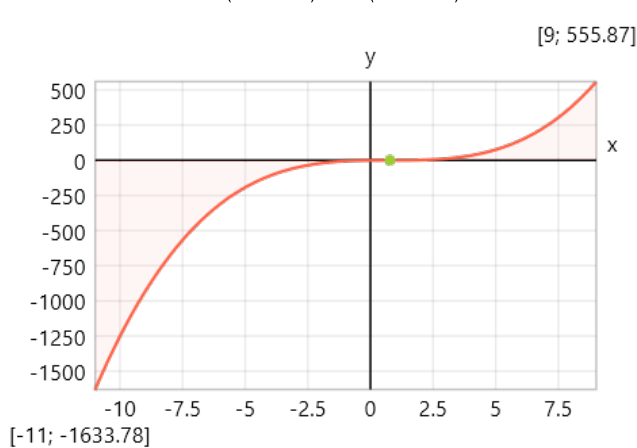
$$x_{35} = \$Root\{f_{35}(x) = 0; x \in [-11; 9]\} = 0.657$$

$$f_{36}(x) = \left(\left|x - \frac{2}{3}\right|\right)^{0.2} \cdot \begin{cases} \text{if } x \leq \frac{2}{3}: & 1 \\ \text{else:} & -1 \end{cases}$$



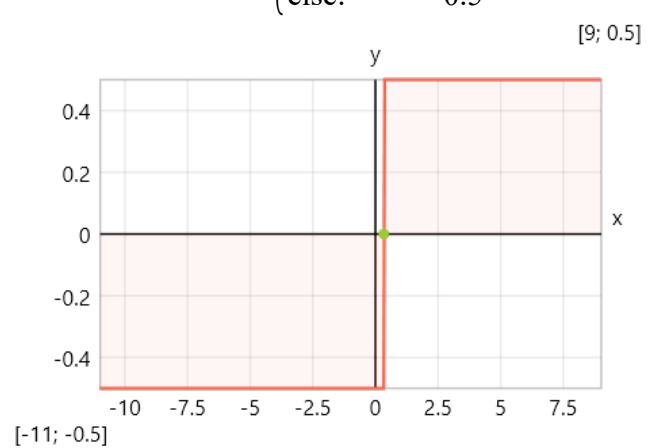
$$x_{36} = \$Find\{f_{36}(x); x \in [-11; 9]\} = 0.667$$

$$f_{37}(x) = \left(x - \frac{7}{9}\right)^3 + \left(x - \frac{7}{9}\right) \cdot 10^{-3}$$



$$x_{37} = \$Root\{f_{37}(x) = 0; x \in [-11; 9]\} = 0.778$$

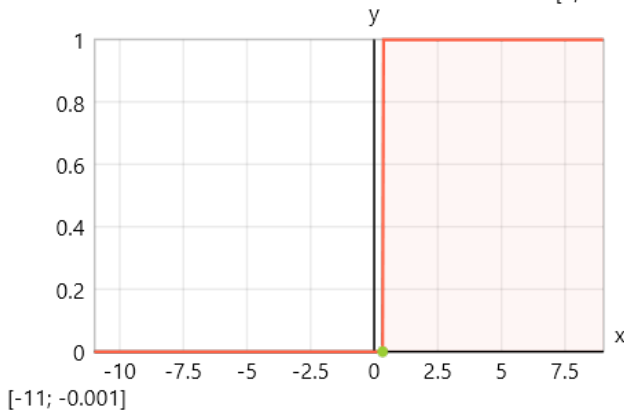
$$f_{38}(x) = \begin{cases} \text{if } x \leq \frac{1}{3}: & -0.5 \\ \text{else:} & 0.5 \end{cases}$$



$$x_{38} = \$Find\{f_{38}(x); x \in [-11; 9]\} = 0.333$$

$$f_{39}(x) = \begin{cases} \text{if } x \leq \frac{1}{3}: & -(10^{-3}) \\ \text{else:} & 1 - 10^{-3} \end{cases}$$

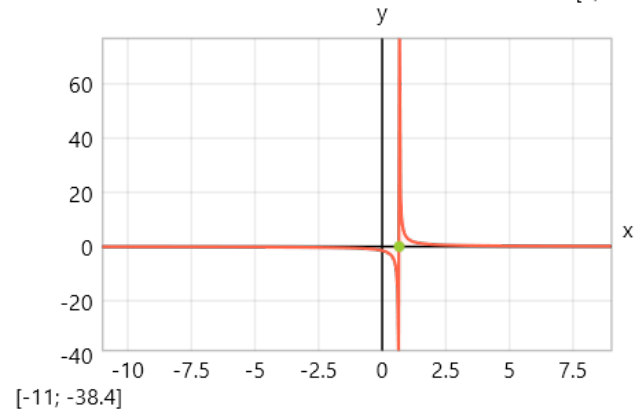
[9; 0.999]



$$x_{39} = \$Find \{f_{39}(x); x \in [-11; 9]\} = 0.333$$

$$f_{40}(x) = \begin{cases} \text{if } x \equiv 0: & 0 \\ \text{else:} & \frac{1}{x - 2/3} \end{cases}$$

[9; 76.8]

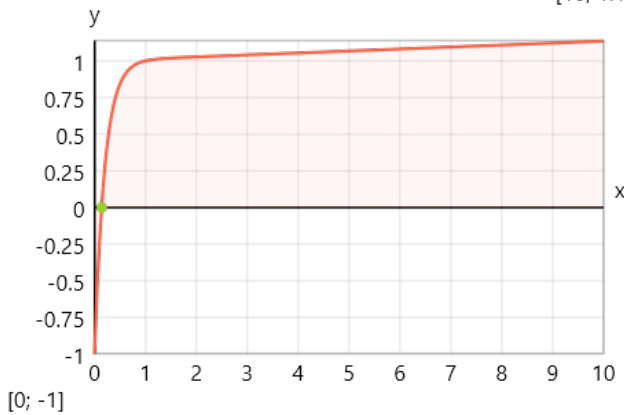


$$x_{40} = \$Find \{f_{40}(x); x \in [-11; 9]\} = 0.667$$

A. Swift, G. R. Lindfield, *Comparison of a continuation method with Brent's method for the numerical solution of a single nonlinear equation*, The Computer Journal, Volume 21, Issue 4, 1978, p. 359–362
<https://doi.org/10.1093/comjnl/21.4.359>

$$f_{41}(x) = 2 \cdot x \cdot e^{-5} - 2 \cdot e^{-5 \cdot x} + 1$$

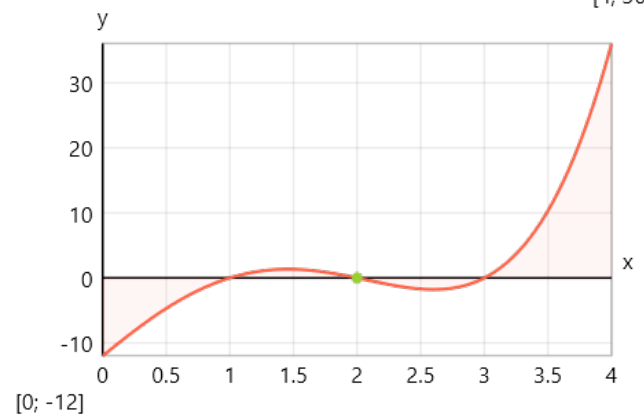
[10; 1.13]



$$x_{41} = \$Root \{f_{41}(x) = 0; x \in [0; 10]\} = 0.138$$

$$f_{42}(x) = (x^2 - x - 6) \cdot (x^2 - 3 \cdot x + 2)$$

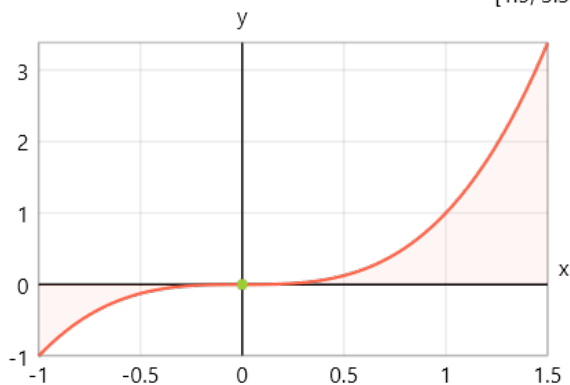
[4; 36]



$$x_{42} = \$Root \{f_{42}(x) = 0; x \in [0; 4]\} = 2$$

$$f_{43}(x) = x^3$$

[1.5; 3.38]

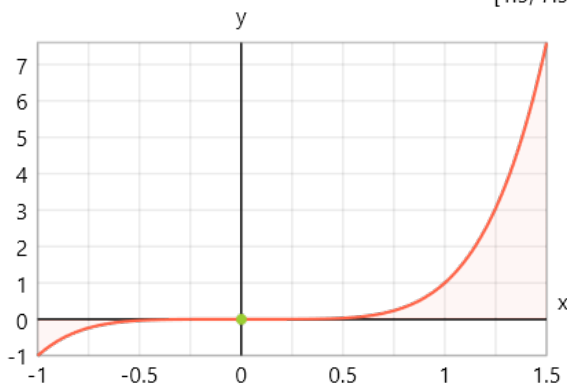


[-1; -1]

$$x_{43} = \text{\$Root} \{ f_{43}(x) = 0; x \in [-1; 1.5] \} = -1.46 \times 10^{-11}$$

$$f_{44}(x) = x^5$$

[1.5; 7.59]

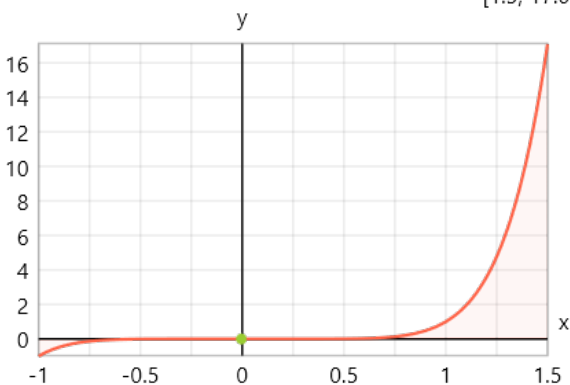


[-1; -1]

$$x_{44} = \text{\$Root} \{ f_{44}(x) = 0; x \in [-1; 1.5] \} = 2.38 \times 10^{-7}$$

$$f_{45}(x) = x^7$$

[1.5; 17.09]

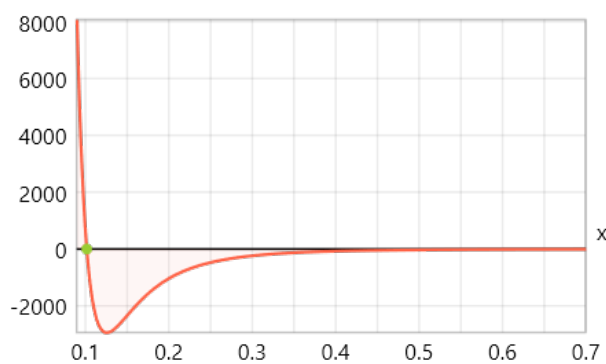


[-1; -1]

$$x_{45} = \text{\$Root} \{ f_{45}(x) = 0; x \in [-1; 1.5] \} = -1.53 \times 10^{-5}$$

$$f_{46}(x) = \frac{e^{-5 \cdot x} - x - 0.5}{x^5}$$

[0.7; 8065.87]

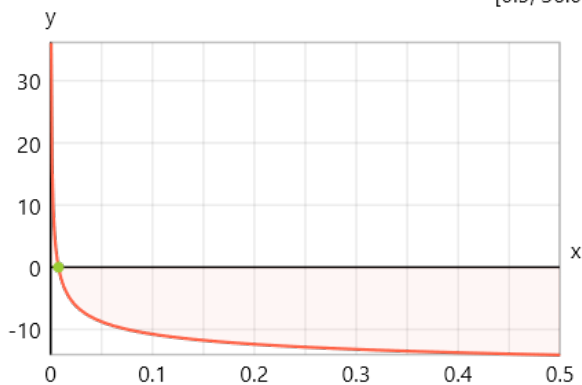


[0.09; -2941.47]

$$x_{46} = \text{\$Root} \{ f_{46}(x) = 0; x \in [0.09; 0.7] \} = 0.102$$

$$f_{47}(x) = \frac{1}{\sqrt{x}} - 2 \cdot \ln(5 \cdot 10^3 \cdot \sqrt{x}) + 0.8$$

[0.5; 36.09]

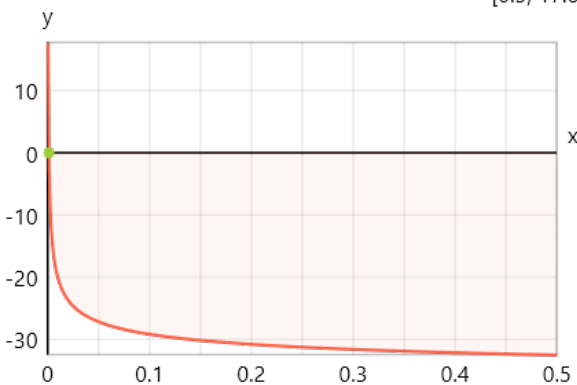


[0.0005; -14.13]

$$x_{47} = \text{\$Root} \{ f_{47}(x) = 0; x \in [0.0005; 0.5] \} = 0.00773$$

$$f_{48}(x) = \frac{1}{\sqrt{x}} - 2 \cdot \ln(5 \cdot 10^7 \cdot \sqrt{x}) + 0.8$$

[0.5; 17.67]

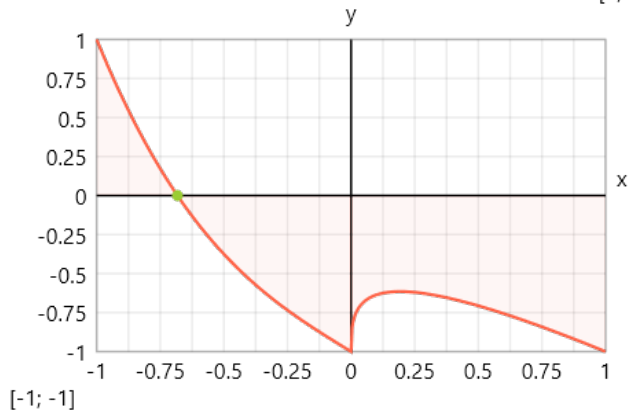


[0.0005; -32.55]

$$x_{48} = \text{\$Root} \{ f_{48}(x) = 0; x \in [0.0005; 0.5] \} = 0.00128$$

$$f_{49}(x) = \begin{cases} \text{if } x \leq 0: & -(x^3) - x - 1 \\ \text{else:} & x^{\frac{1}{3}} - x - 1 \end{cases}$$

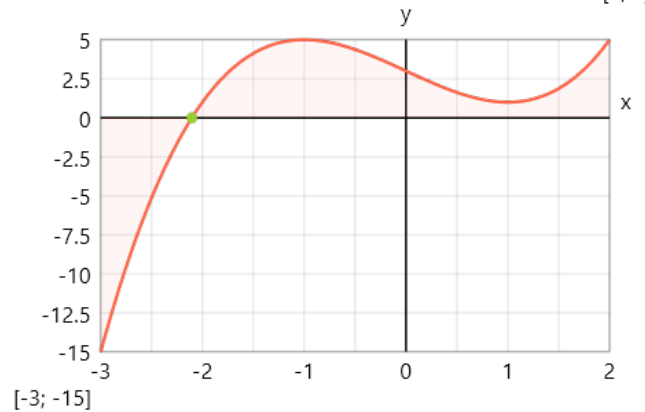
[1; 1]



$$x_{49} = \text{\$Root}\{f_{49}(x)=0; x \in [-1; 1]\} = -0.682$$

$$f_{50}(x) = x^3 - 2 \cdot x - x + 3$$

[2; 5]



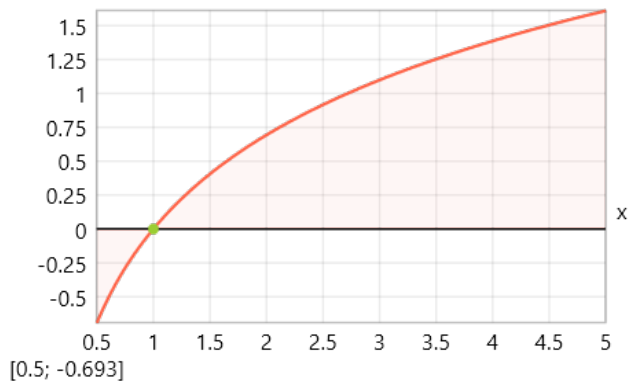
$$x_{50} = \text{\$Root}\{f_{50}(x)=0; x \in [-3; 2]\} = -2.1$$

Alojz Suhadolnik, Combined bracketing methods for solving nonlinear equations, Applied Mathematics Letters, Volume 25, Issue 11, 2012, Pages 1755-1760, ISSN 0893-9659

<https://doi.org/10.1016/j.aml.2012.02.006>

$$f_{51}(x) = \ln(x)$$

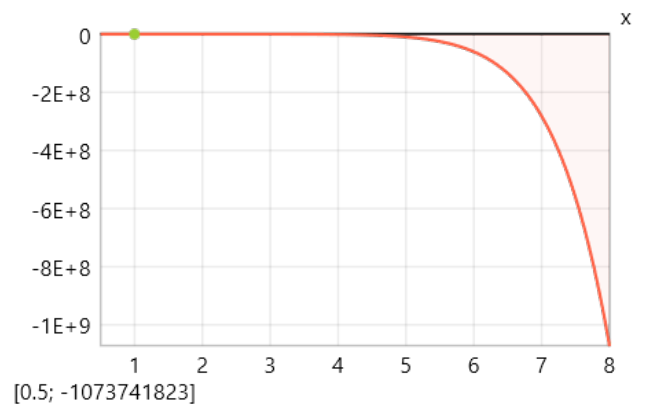
[5; 1.61]



$$x_{51} = \text{\$Root}\{f_{51}(x)=0; x \in [0.5; 5]\} = 1$$

$$f_{52}(x) = (10 - x) \cdot e^{-10 \cdot x} - x^{10} + 1$$

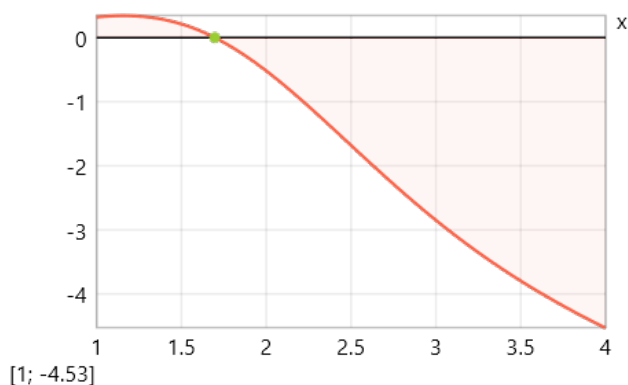
[8; 1.06]



$$x_{52} = \text{\$Root}\{f_{52}(x)=0; x \in [0.5; 8]\} = 1$$

$$f_{53}(x) = e^{\sin(x)} - x - 1$$

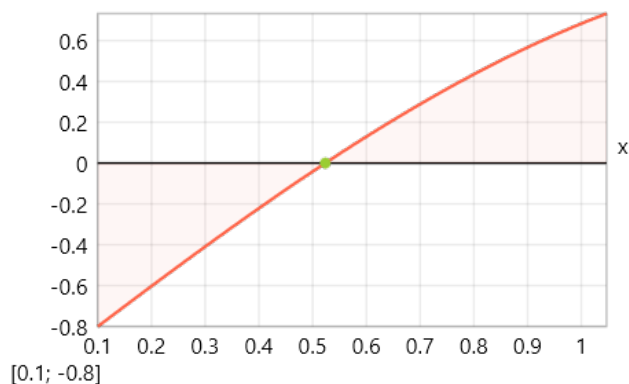
[4; 0.341]



$$x_{53} = \text{\$Root}\{f_{53}(x) = 0; x \in [1; 4]\} = 1.7$$

$$f_{54}(x) = 2 \cdot \sin(x) - 1$$

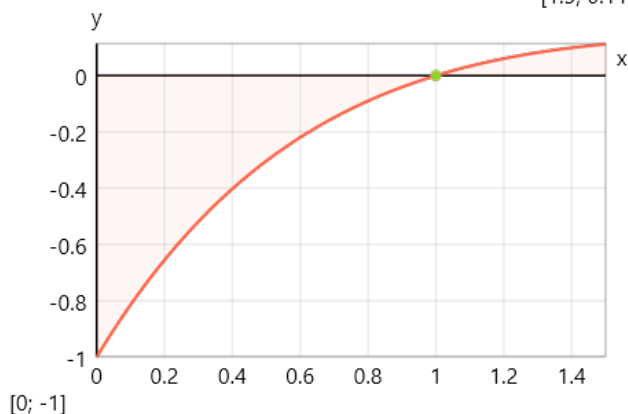
[1.05; 0.732]



$$x_{54} = \text{\$Root}\left\{f_{54}(x) = 0; x \in \left[0.1; \frac{\pi}{3}\right]\right\} = 0.524$$

$$f_{55}(x) = (x - 1) \cdot e^{-x}$$

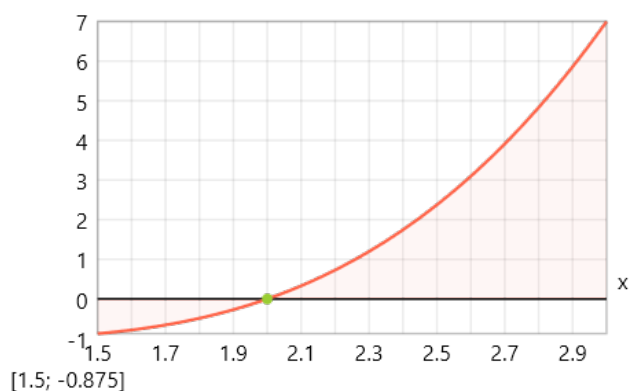
[1.5; 0.112]



$$x_{55} = \text{\$Root}\{f_{55}(x) = 0; x \in [0; 1.5]\} = 1$$

$$f_{56}(x) = (x - 1)^3 - 1$$

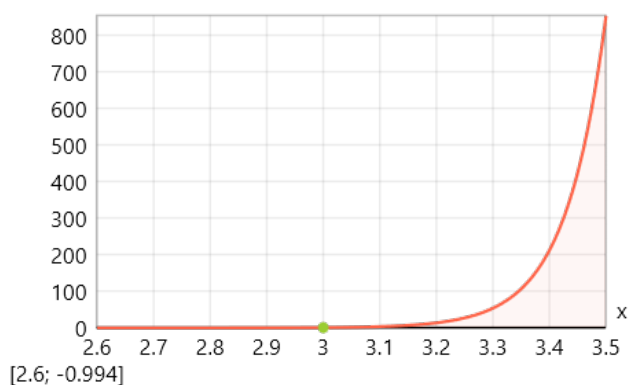
[3; 7]



$$x_{56} = \text{\$Root}\{f_{56}(x) = 0; x \in [1.5; 3]\} = 2$$

$$f_{57}(x) = e^{x^2 + 7 \cdot x - 30} - 1$$

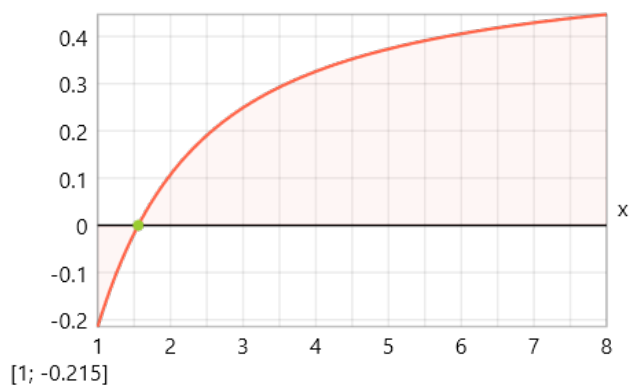
[3.5; 853.06]



$$x_{57} = \text{\$Root}\{f_{57}(x) = 0; x \in [2.6; 3.5]\} = 3$$

$$f_{58}(x) = \text{atan}(x) - 1$$

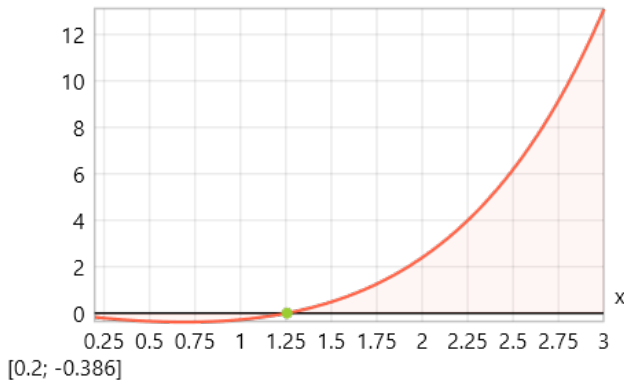
[8; 0.446]



$$x_{58} = \text{\$Root}\{f_{58}(x) = 0; x \in [1; 8]\} = 1.56$$

$$f_{59}(x) = e^x - 2 \cdot x - 1$$

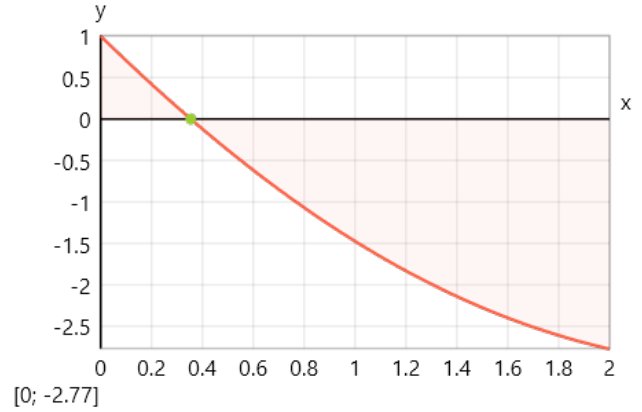
[3; 13.09]



$$x_{59} = \text{\$Root}\{f_{59}(x)=0; x \in [0.2; 3]\} = 1.26$$

$$f_{60}(x) = e^{-x} - x - \sin(x)$$

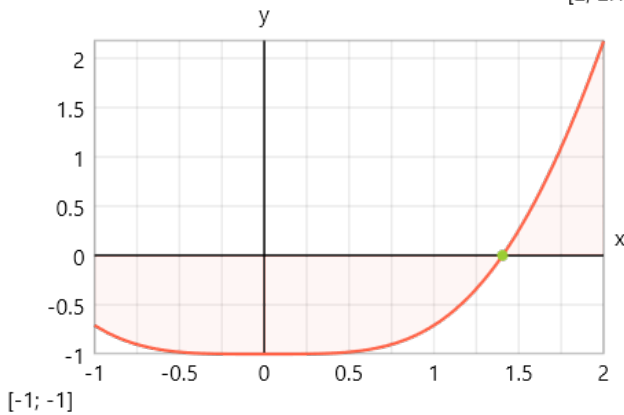
[2; 1]



$$x_{60} = \text{\$Root}\{f_{60}(x)=0; x \in [0; 2]\} = 0.354$$

$$f_{61}(x) = x^2 - \sin(x)^2 - 1$$

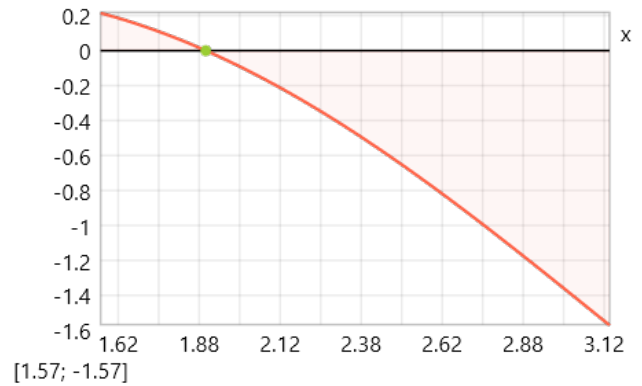
[2; 2.17]



$$x_{61} = \text{\$Root}\{f_{61}(x)=0; x \in [-1; 2]\} = 1.4$$

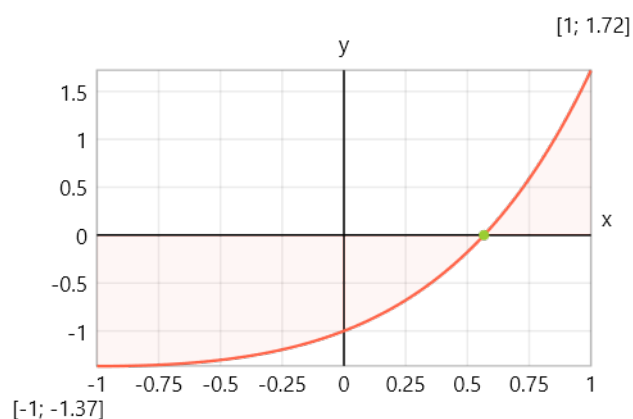
$$f_{62}(x) = \sin(x) - x/2$$

[3.14; 0.215]



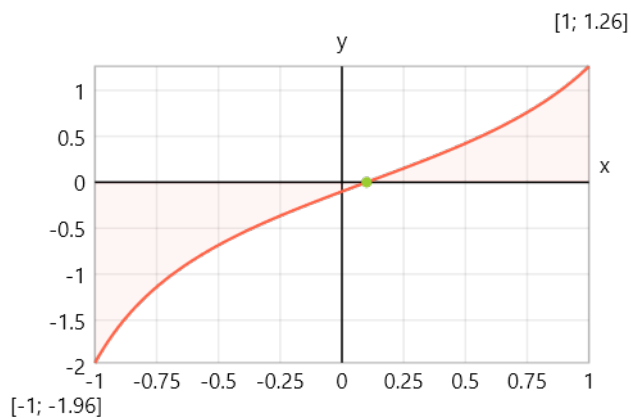
$$x_{62} = \text{\$Root}\{f_{62}(x)=0; x \in [\pi/2; \pi]\} = 1.9$$

Lambert - $f_{63}(x) = x \cdot \exp(x) - 1$



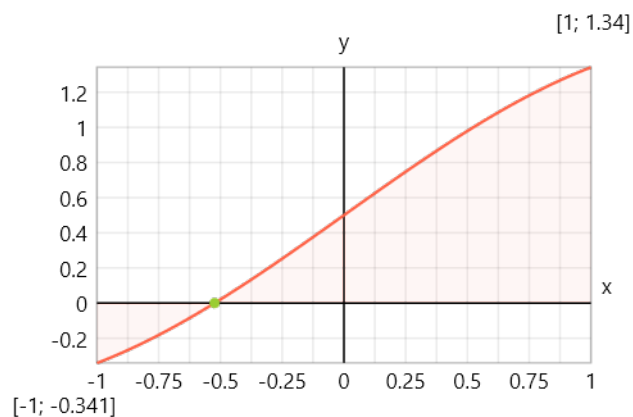
$x_{63} = \text{\$Root}\{f_{63}(x)=0; x \in [-1; 1]\} = 0.567$

Trigonometric 1 - $f_{64}(x) = \tan\left(x - \frac{1}{10}\right)$



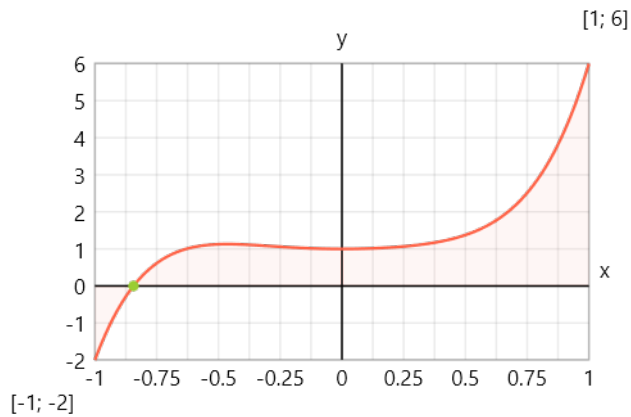
$x_{64} = \text{\$Root}\{f_{64}(x)=0; x \in [-1; 1]\} = 0.1$

Trigonometric 2 - $f_{65}(x) = \sin(x) + 0.5$



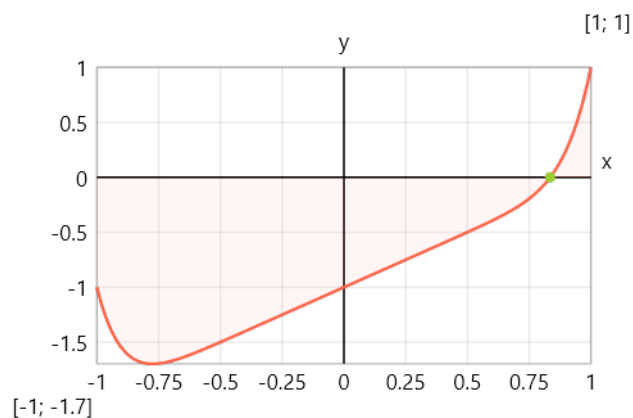
$x_{65} = \text{\$Root}\{f_{65}(x)=0; x \in [-1; 1]\} = -0.524$

Polynomial 1 - $f_{66}(x) = 4 \cdot x^5 + x \cdot x + 1$



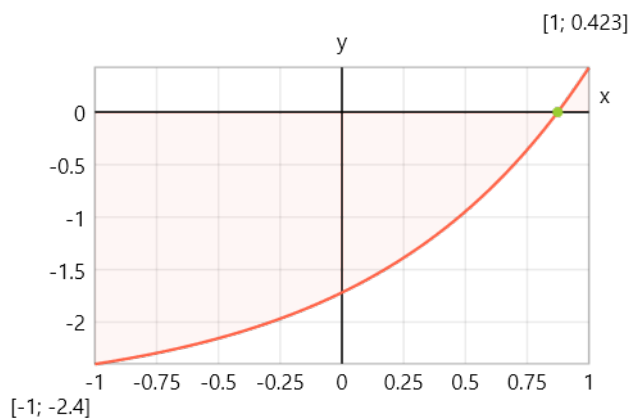
$x_{66} = \text{\$Root}\{f_{66}(x)=0; x \in [-1; 1]\} = -0.844$

Polynomial 2 - $f_{67}(x) = x + x^{10} - 1$



$x_{67} = \text{\$Root}\{f_{67}(x)=0; x \in [-1; 1]\} = 0.835$

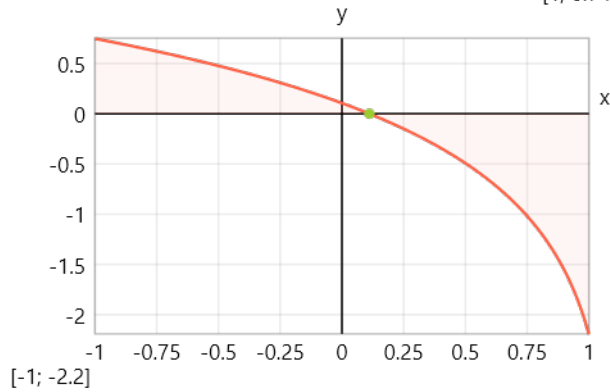
Exponential - $f_{68}(x) = \pi^x - e$



$x_{68} = \text{\$Root}\{f_{68}(x)=0; x \in [-1; 1]\} = 0.874$

Logarithmic - $f_{69}(x) = \ln\left(\left|x - \frac{10}{9}\right|\right)$

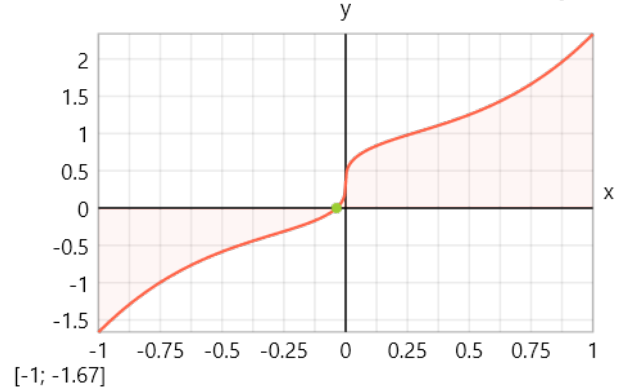
[1; 0.747]



$x_{69} = \text{\$Root}\{f_{69}(x) = 0; x \in [-1; 1]\} = 0.111$

Polynomial - $f_{70}(x) = \frac{1}{3} + \text{sign}(x) \cdot \sqrt[3]{|x|} + x^3$

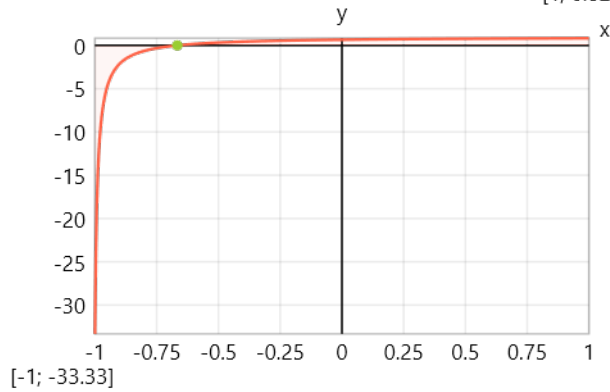
[1; 2.33]



$x_{70} = \text{\$Root}\{f_{70}(x) = 0; x \in [-1; 1]\} = -0.037$

Poly. Frac. - $f_{71}(x) = \frac{x + 2/3}{x + 101/100}$

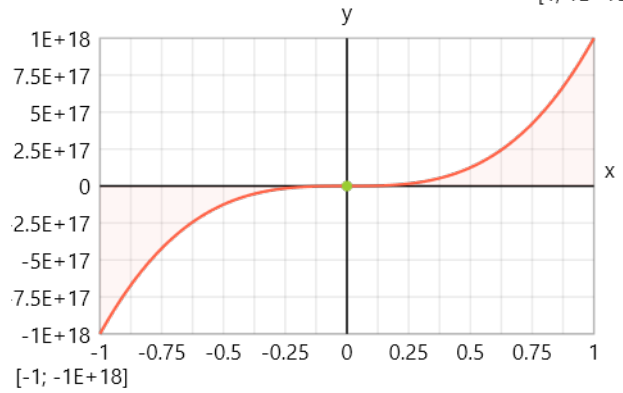
[1; 0.829]



$x_{71} = \text{\$Root}\{f_{71}(x) = 0; x \in [-1; 1]\} = -0.667$

Polynomial 3 - $f_{72}(x) = (x \cdot 10^6 - 1)^3$

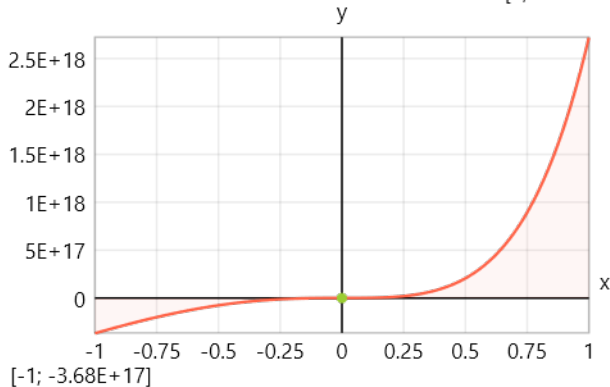
[1; 1E+18]



$x_{72} = \text{\$Root}\{f_{72}(x) = 0; x \in [-1; 1]\} = 10^{-6}$

Exp. Poly. - $f_{73}(x) = \exp(x) \cdot (x \cdot 10^6 - 1)^3$

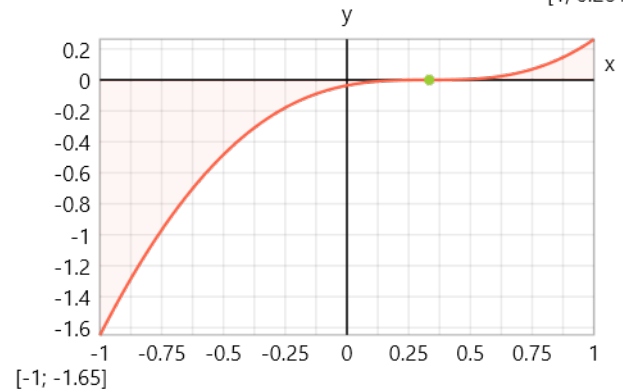
[1; 2.72E+18]



$x_{73} = \text{\$Root}\{f_{73}(x) = 0; x \in [-1; 1]\} = 10^{-6}$

Tan. Poly. - $f_{74}(x) = \left(x - \frac{1}{3}\right)^2 \cdot \left(\text{atan}\left(x - \frac{1}{3}\right)\right)$

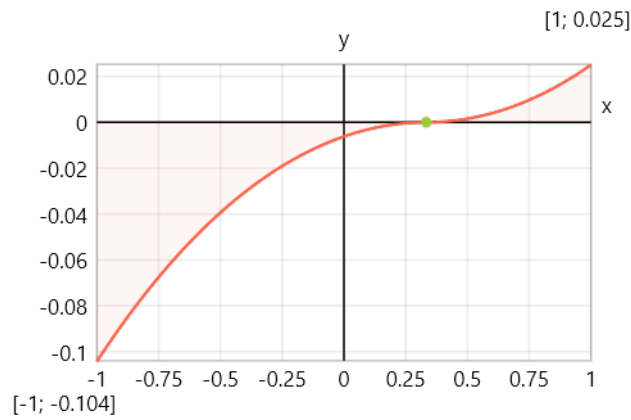
[1; 0.261]



$x_{74} = \text{\$Root}\{f_{74}(x) = 0; x \in [-1; 1]\} = 0.333$

Circles

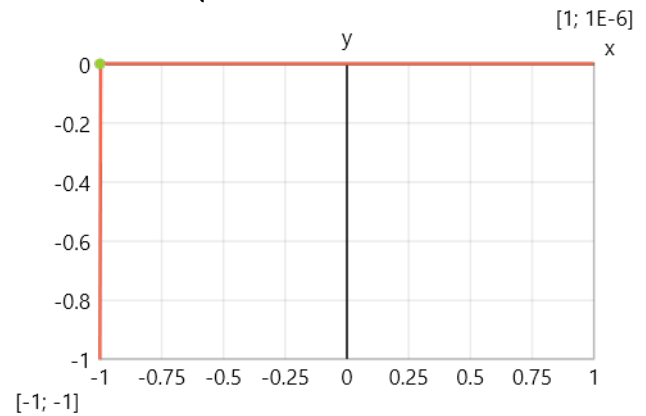
$$f_{75}(x) = \text{sign}(3 \cdot x - 1) \cdot \left(1 - \sqrt{1 - \frac{(3 \cdot x - 1)^2}{81}} \right)$$



$$x_{75} = \$\text{Root} \{ f_{75}(x) = 0; x \in [-1; 1] \} = 0.333$$

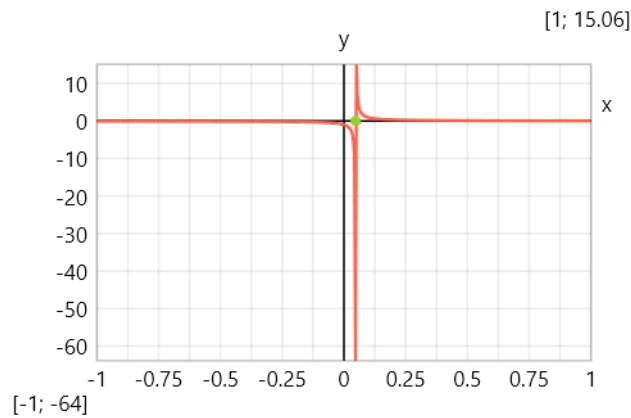
Step Function

$$f_{76}(x) = \begin{cases} \text{if } x > \frac{1 - 10^6}{10^6}: & \frac{1 + 10^6}{10^6} - 1 \\ \text{else:} & 0 \end{cases}$$



$$x_{76} = \$\text{Find} \{ f_{76}(x); x \in [-1; 1] \} = -1$$

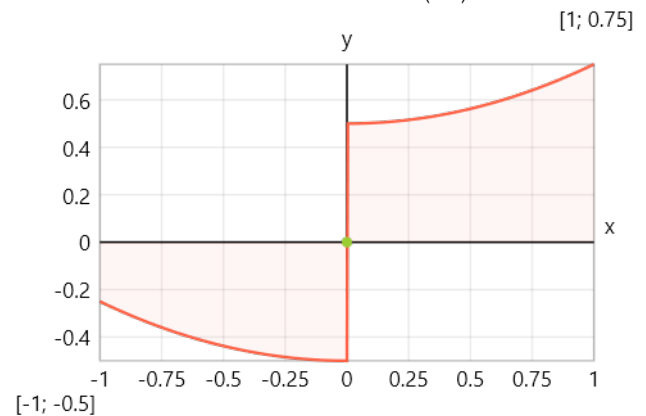
Geometric - $f_{77}(x) = \begin{cases} \text{if } x \neq \frac{1}{21}: & \frac{1}{21 \cdot x - 1} \\ \text{else:} & 0 \end{cases}$



$$x_{77} = \$\text{Find} \{ f_{77}(x); x \in [-1; 1] \} = 0.0476$$

Trunc. Poly.

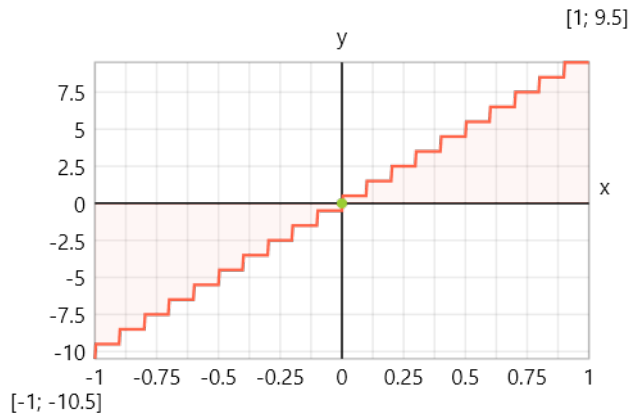
$$f_{78}(x) = \frac{x \cdot x}{4} + \text{ceiling} \left(\frac{x}{2} \right) - 0.5$$



$$x_{78} = \$\text{Find} \{ f_{78}(x); x \in [-1; 1] \} = 7.11 \times 10^{-15}$$

Staircase

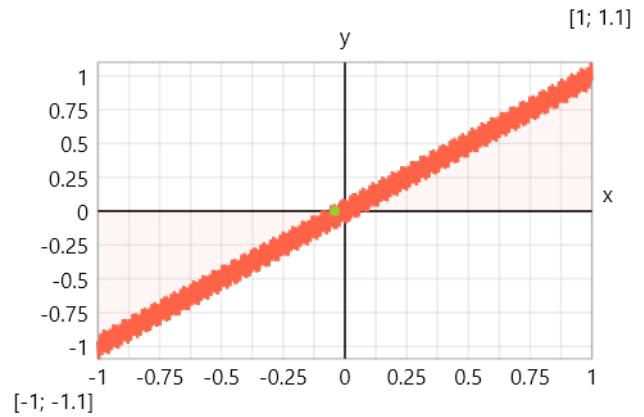
$$f_{79}(x) = \text{ceiling}(10 \cdot x - 1) + 0.5$$



$$x_{79} = \$\text{Find} \{ f_{79}(x); x \in [-1; 1] \} = 2.91 \times 10^{-19}$$

Noisy Line

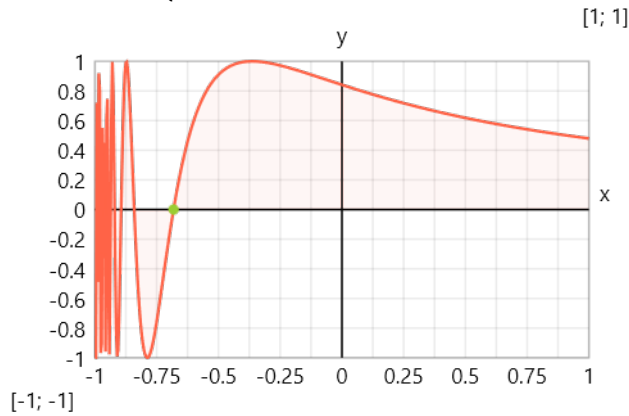
$$f_{80}(x) = x + \frac{\sin(x \cdot 10^6)}{10} + 10^{-3}$$



$$x_{80} = \$\text{Root} \{ f_{80}(x) = 0; x \in [-1; 1] \} = -0.0415$$

Warsaw

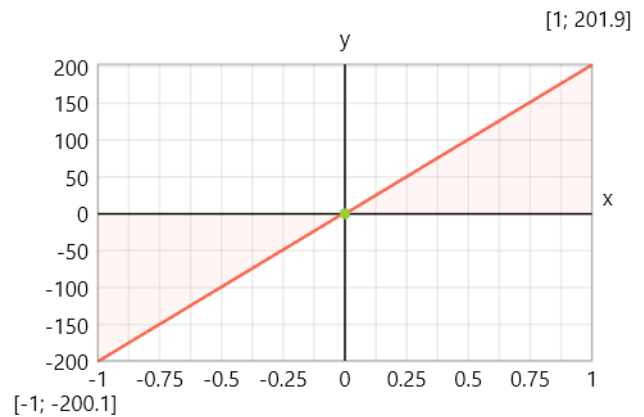
$$f_{81}(x) = \begin{cases} \text{if } x > (-1): & 1 + \sin\left(\frac{1}{x+1}\right) - 1 \\ \text{else:} & 0 \end{cases}$$



$$x_{81} = \$\text{Root} \{ f_{81}(x) = 0; x \in [-1; 1] \} = -0.682$$

Sawtooth

$$f_{82}(x) = 202 \cdot x - 2 \cdot \text{floor}\left(\frac{2 \cdot x + 10^{-2}}{2} \cdot 10^{-2}\right) - 0.1$$



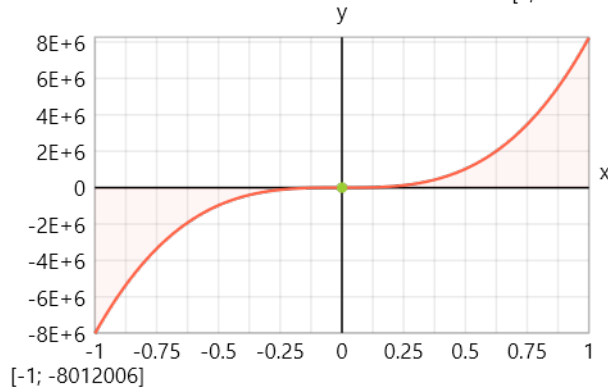
$$x_{82} = \$\text{Root} \{ f_{82}(x) = 0; x \in [-1; 1] \} = 0.000495$$

SciML Benchmarks test suite

Sawtooth Cube

$$f_{83}(x) = \left(202 \cdot x - 2 \cdot \text{floor} \left(\frac{2 \cdot x + 10^{-2}}{2} \cdot 10^{-2} \right) - 0.1 \right)^3$$

[1; 8230173]

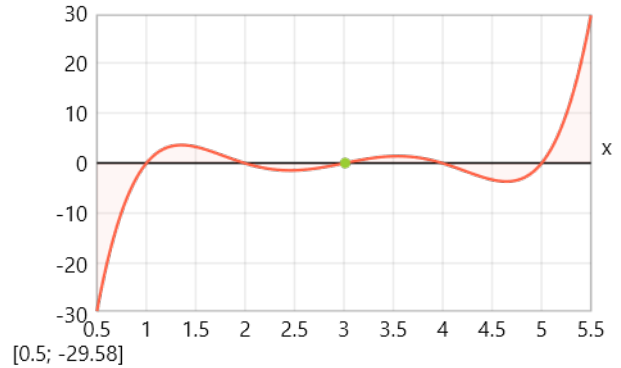


$$x_{83} = \text{\$Root} \{ f_{83}(x) = 0; x \in [-1; 1] \} = 0.000495$$

Polynomial with multiple roots

$$f_{84}(x) = (x-1) \cdot (x-2) \cdot (x-3) \cdot (x-4) \cdot (x-5) - 0.05$$

[5.5; 29.48]

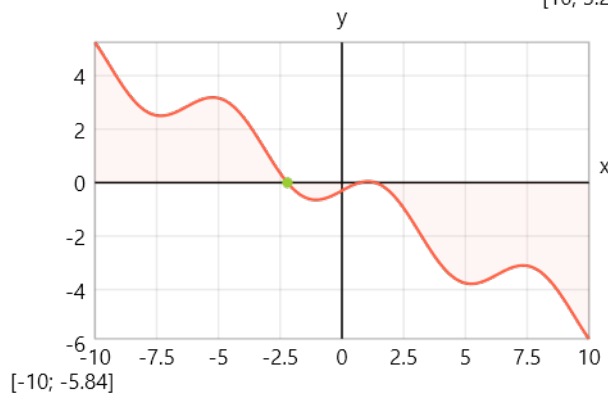


$$x_{84} = \text{\$Root} \{ f_{84}(x) = 0; x \in [0.5; 5.5] \} = 3.01$$

Trigonometric with multiple roots

$$f_{85}(x) = \sin(x) - 0.5 \cdot x - 0.3$$

[10; 5.24]

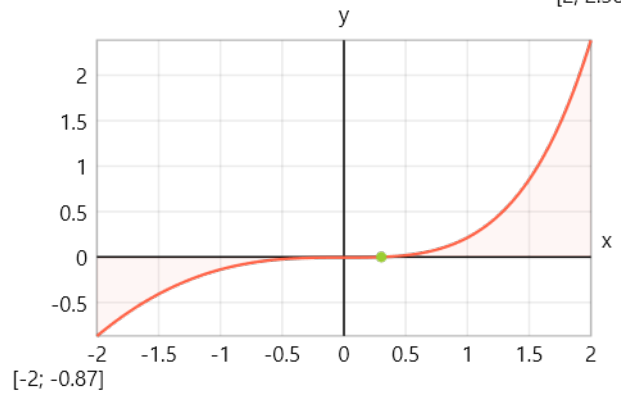


$$x_{85} = \text{\$Root} \{ f_{85}(x) = 0; x \in [-10; 10] \} = -2.21$$

Exponential function (sensitive near zero)

$$f_{86}(x) = \exp(x) - 1 - x - \frac{x \cdot x}{2} - 0.005$$

[2; 2.38]

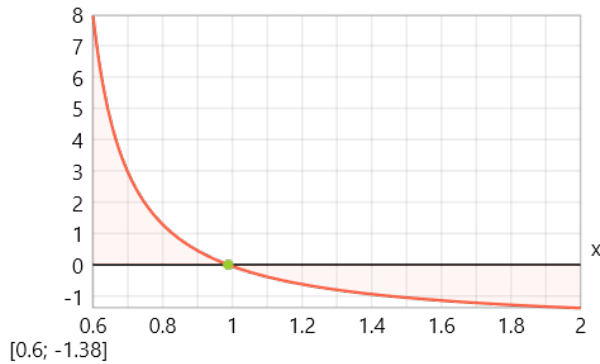


$$x_{86} = \text{\$Root} \{ f_{86}(x) = 0; x \in [-2; 2] \} = 0.303$$

Rational function with pole

$$f_{87}(x) = \frac{1}{x-0.5} - 2 - 0.05$$

[2; 7.95]

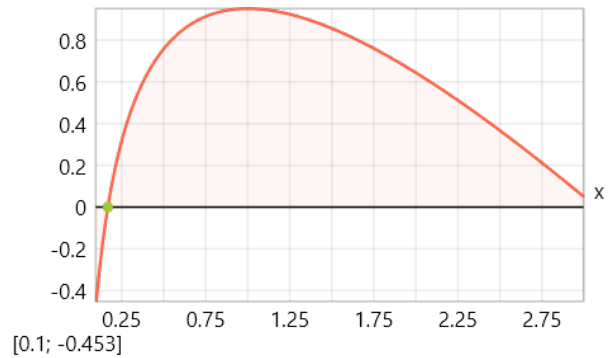


$$x_{87} = \text{\$Root}\{f_{87}(x)=0; x \in [0.6; 2]\} = 0.988$$

Logarithmic function

$$f_{88}(x) = \ln(x) - x + 2 - 0.05$$

[3; 0.95]

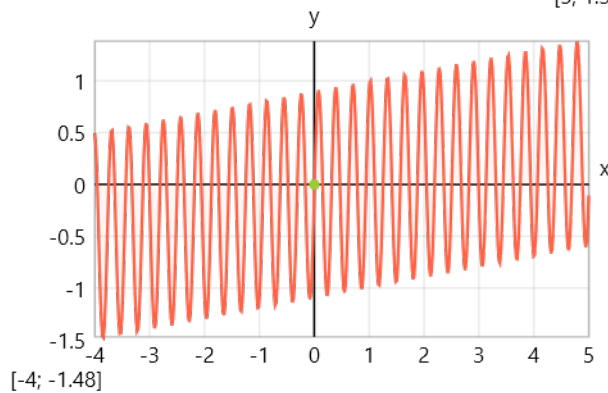


$$x_{88} = \text{\$Root}\{f_{88}(x)=0; x \in [0.1; 3]\} = 0.168$$

High oscillation function

$$f_{89}(x) = \sin(20 \cdot x) + 0.1 \cdot x - 0.1$$

[5; 1.38]

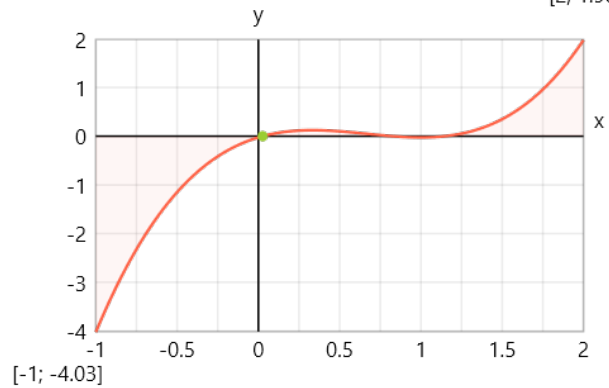


$$x_{89} = \text{\$Root}\{f_{89}(x)=0; x \in [-4; 5]\} = -0.794$$

Function with very flat region

$$f_{90}(x) = x \cdot x \cdot x - 2 \cdot x \cdot x + x - 0.025$$

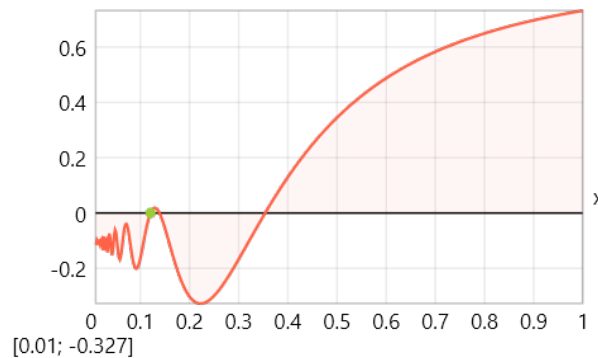
[2; 1.98]



$$x_{90} = \text{\$Root}\{f_{90}(x)=0; x \in [-1; 2]\} = 0.0264$$

Bessel-like function - $f_{91}(x) = x \cdot \sin\left(\frac{1}{x}\right) - 0.1 - 0.01$

[1; 0.731]



$$x_{91} = \text{\$Root}\{f_{91}(x)=0; x \in [0.01; 1]\} = 0.121$$