HP35s - f(x) = 0

Note: If you would like to try using an HP calculator, you can download a free app on your cell phone

- Android: Free42. HP42s calculator (almost identical to an HP35s but out of production)
- Apple: ComplexRPN A generic RPN calculator which does complex numbers

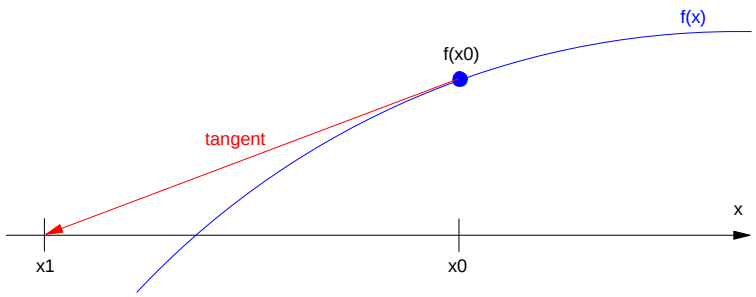
Newton's Method

Newton's method is a way to find the zero of a function. The method is

- First, guess x.
- Find the derivative at x.
- Use the derivative to estimate the zero crossing as

$$x_1 = x_0 - \left(\frac{dx}{dy}\right)_{x=x_0} \cdot y(x_0)$$

- If y(x1) isn't small enough, repeat



Newton's Method: Use the derivative to estimate the zero crosing.

HP42s Program

Memory Location: X = current guess, Y = f(x)

Program:

- Z = find the zero of a funciton
- F = function

Code:

```
PRGM
LBL Z
VIEW X
PSE
RCL X
XEQ F001
STO Y
RCL X
0.001
+
XEQ F001
RCL Y
-
1/X
0.001
+
XEQ F001
RCL Y
-
1/X
0.001
x
RCL Y
x
+/-
RCL X
+
STO X
XEQ F001
ABS
1E-4
X<Y?
GTO Z001
RCL X
STOP
PRGM
```

Using f(x) = 0

Example 1: Find the square root of two

$$x = \sqrt{2}$$

Change this to f(x) = 0

$$y = x^2 - 2$$

Program this into program F. Your guess is passed in the x-register

```
PRGM
LBL F
X²
2
-
RTN
PRGM
```

Place your initial guess into the X register.

```
10
STO X
```

Execute the program Z

```
XEQ Z000
```

You'll see several numbers appear as it iterates to find the solution. After a few tries, the result is

```
1.414
```

Example 2: Find the current through a diode

$$V_d = 0.052 \ln\left(\frac{I_d}{10^{-8}} + 1\right)$$

$$V_d + 100 I_d = 10V$$

Solution: Rewrite this as f(x) = 0. Assume your initial guess is Id in mA. Solve two equations

$$V_{d1} = 0.052 \ln\left(\frac{I_d}{10^{-8}} + 1\right)$$

$$V_{d2} = 10V - 100 I_d$$

The error is the difference

$$e = V_{d1} - V_{d2}$$

Program this into the HP35s

```
GTO F000
PRGM
1000
/
STO I                  I is now in amps
1E-8
/
1
+
LN
0.052
x
STO V
10
RCL I
100
x
-
RCL V
-
RTN
PRGM
```

Now start with an initial guess (1mA)

```
1
STO X
XEQ Z000
```

You will see the display change as the f(x) = 0 function iterates to find the solution. Eventually you get

```
91.664                 I = 91.664mA
```

To check your answer, plug this into function F

```
XEQ F000

-5.840E-9
```

f(x) = -0.000 000 00584 (almost zero)