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Worksheet n° 1

Solving Non-linear Equations $f(x) = 0$ and Error Analysis

Exercise n° 1:

All digits in the following numbers are **correct**. Calculate the absolute and relative errors:
a) 0.1342 *b*) 7.480 *c*) 0.34235×10^{-3} *d*) 7.000

Exercise n° 2:

Let $x = 0.1256$ be given with an error of 0.5%..

1) Give the absolute error of x.
2) Determine the exact number of significant digits of this number.
3) Round the result to the last csd .

Exercise n° 3:

Let: $x = 2.5 \pm 0.01$; $y = 1.2 \pm 0.02$; $z = 3.2 \pm 0.03$; $t = 5.1 \pm 0.01$.
1) Verify that all digits of x, y, z, and t are **correct**.
2) Let $S = x^2 + y^2 + z^2 + t^2$.
a) Determine the number of **CSD** of S.
b) Round the result to the last **CSD** and give the final result.

***Exercise n° 4:**

Let: $x = 5.27 \pm 0.01$; $y = 28.61 \pm 0.04$; $z = 15.80 \pm 0.02$.
Calculate for $f = \dfrac{x^2 y^{1/3}}{z^3}$:
a) The value of f and its relative and absolute errors.
b) Give the final result of f in the form $f^* \pm \Delta f$.

Exercise n ∘ 5:

Consider the equation $f(x) = x^3 - x - 3 = 0$.
1) Graphically find an interval [a, b] of length 1 containing the root α.
2) Using the bisection method with precision $\varepsilon = 10^{-2}$:
a) Calculate the number of iterations needed.
b) Find the root α.

Exercise n ∘ 6:

Calculate $\sqrt{3}$ with a precision of $\varepsilon = 10^{-2}$ using the bisection method (Hint: use $**f(x) = x^2 - 3$).

Exercise n ∘ 7:

Consider $f(x) = exp(x)x2 = 0$. 1) Show that f(x) = 0 has a unique solution $\alpha \in [1, 2]$.
2) Consider the fixed-point forms: $g_1(x) = e^x 2$ and $g_2(x) = ln(x + 2)$.
a) Which function satisfies the fixed-point conditions? Justify.
b) Starting with x0 = 1.5, calculate the number of iterations for $\varepsilon = 10^{-3}$

c) Calculate the root α.

Exercise n∘ 8:

Let $f(x) = xlnx - 3 = 0$.

1) Show that the root lies in $[2, 3]$.

2) Verify that the function satisfies the necessary conditions for the Newton-Raphson method to converge in the interval $[2, 3]$.

3) Calculate the root using the Newton-Raphson method with $\varepsilon = 10^{-3}$.