

Klausur Computational Physics I
WS 2017/18

Es sind insgesamt 21 Punkte zu erreichen. Erwartet wird die Bearbeitung von Aufgaben im Umfang von 18 Punkten.

Dokumentieren Sie Ihre Ergebnisse in schriftlicher Form und reichen Sie ihre Programme ein (bitte gezippt!):

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Bearbeitungszeit: 2 h

A1: Sums

The energy for a charge Q at position x in a one-dimensional lattice of alternating charge $\pm q$ at positions $n\ell$ is given by $E = qQ/(4\pi\epsilon_0)S$ with the sum

$$S = \sum_{n=-\infty}^{\infty} \frac{(-1)^n}{|x + n\ell|} \quad (1)$$

Take $x = 0.2$ and $\ell = 1$: How many terms do you have to add to get the sum S correctly to within 10^{-5} ?

4P

A2: Zeros

Determine the zeros of the function

$$\cos(x) \sinh(x) - 1 = 0 \quad (2)$$

in the interval $(0, 20)$.

4P

A3: Ordinary differential equation

Solve the ordinary differential equation

$$\ddot{x} + (4x^2 - 2)\dot{x} + x^5 - 2x^3 + 2x = 0 \quad (3)$$

with initial conditions

$$x(0) = 1 \quad \dot{x}(0) = 0 \quad (4)$$

and determine position and velocity at $t = 4$. What method did you use, and how many time steps did you take?

5P

A.4 Quantum eigenvalues

Determine the lowest five eigenfunctions and eigenvalues for the Hamilton operator $H = -d^2/dx^2 + V(x)$ with the potential $V(x) = x^4 - 2x^2$.

What method did you use and how do you verify the accuracy of your results?

4P

A.5 Matrix inversion

Solve the linear system $Ax = b$ with

$$\begin{pmatrix} 10 & -7 & 0 \\ -3 & 2 & 6 \\ 5 & -1 & 5 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} 7.1 \\ 3.9 \\ 6 \end{pmatrix} \quad (5)$$

and compute the residual $r = Ax - b$ and the condition number of the matrix.

4P