PY2105 Introduction to Computational Physics

Autumn 2019

Dr. A. Kiely

Problem Set 3

3.1 Write a C/C++ program fulfilling the following task: The user should enter the 3-dimensional velocity vector $\vec{v}$ of a particle, its charge q and the 3-dimensional magnetic field vector $\vec{B}$. The program then calculates the Lorentz force $\vec{F} = q\vec{v} \times \vec{B}$ and prints the resulting vector on the screen.

3.2 Write a C/C++ program fulfilling the following task: The user should enter the 3-dimensional force vector $\vec{F}$ and a 3-dimensional length vector $\vec{s}$. The force is assumed to be constant. The program then calculates the work $W = \vec{F} \cdot \vec{s}$ and prints the result on the screen.

3.3 Write a C/C++ program fulfilling the following task: The user enters a 3-dimensional "double" vector $\vec{v}$ and a 3×3 "double" matrix $\hat{M}$. The program calculates the matrix/vector product $\hat{M}\vec{v}$ and prints the resulting vector on the screen. Use numerical arrays!

3.4 The position $x(t)$ of an object moving horizontally with a constant velocity v is described by the equation

$$\frac{dx(t)}{dt} = v\,. \tag{1}$$

(a) Derive the Euler method/approximation in this case.

(b) Write a C/C++ program which solves this differential equation (1) numerically using the Euler method. The user should be able to enter the velocity v, the initial value $x(0)$ and the final time T at the beginning of the program. At the end the program should plot the numerical solution for times $0 \leq t \leq T$.

(c) Calculate the exact accuracy of the Euler method in this special case.

The hand-written parts should be put in the post box of A. Kiely (across the hall from Kane 201). Submit the programs and results to "Canvas" using the following name convention:
Surname_Firstname_3_1.cxx
Surname_Firstname_3_2.cxx
Surname_Firstname_3_3.cxx
Surname_Firstname_3_4.cxx

The deadline is

Tuesday, 15th October, 18:00