UNIVERSITÀ DI PAVIA

Anno Accademico 2020/2021

COMPUTATIONAL METHODS IN PHYSICS	
Enrollment year	2020/2021
Academic year	2020/2021
Regulations	DM270
Academic discipline	FIS/02 (THEORETICAL PHYSICS, MATHEMATICAL MODELS AND METHODS)
Department	DEPARTMENT OF PHYSICS
Course	
Curriculum	Fisica nucleare e subnucleare
Year of study	1°
Period	2nd semester (01/03/2021 - 11/06/2021)
ECTS	6
Lesson hours	48 lesson hours
Language	Italian
Activity type	ORAL TEST
Teacher	PICCININI FULVIO (titolare) - 6 ECTS
Prerequisites	Basic konwledge of mathematics and physics, as treated in scientific Bachelor Courses. Basic knowledge of Computer Science can be a plus but it is not required.
Learning outcomes	Learning and application of the main algorithms used for the numerical solution of problems in classical and quantum physics. One of the main goals of the course is to develop the necessary mental attitude to solve a problem from the numerical point of view. For this reason all the algorithms are shown theoretically and also through their use in solving physics problems which admit an analytical solution, so that a critical comparison between numerical and analytical solution can be carried out. After this phase, some obtained results for particular problems, which do not admit an analytical solution, are discussed.

Course contents

- Basic numerical methods: interpolation, approximation, differentiation, integration, root finding, random number generators
- Ordinary differential equations
- Linear algebra: basic operations with matrices, linear systems, eigenvalue equations
- Monte Carlo methods for numerical integration and, more in general, as simulation methods
- Partial differential equations
- Spectral methods (Fourier analysis).

Teaching methods

Lectures aimed at discussing the conceptual aspects of the treated algorithms. Part of each lecture is a "hands-on" session where to build practically the algorithms,
with their application to some relevant physical problem. In order to directly access the algorithms in practice, simple models of algorithms in fortran language are provided, which are commented
before their usage. Since the focus of the course is the algorithm itself, the student can also use the programming language which she/he prefers.
Lectures are delivered in a laboratory, where some personal computers are provided. The students can also use their own laptops.

Reccomended or required readings

W.H. Press, S.A. Teukolsky, W.T. Vetterling, B.P. Flannery: Numerical Recipes, Cambridge University Press.
S.S.M. Wong: Computational Methods in Physics and Engineering, World Scientific.
P.L. DeVries: A First Course in Computational Physics, John Wiley & Sons, Inc.

Assessment methods

Oral examination. Optionally, the student can bring the results of a numerical study carried out by her-/him-self, for a problem of her/his interest, also not treated during the lectures. During the discussion of the results the student should show why the adopted algorithms have been chosen and how she/he can trust the obtained results.
If the student does not bring an original numerical study, the examination will start with the discussion of the obtained results during one of the numerical sessions of the course.

Further information

Attendance of the lectures is not compulsory. However, since one of the main goals of the course is the development of the mental attitude to numerical problem solving, attendance is strongly recommended.

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