

## Physics 5794 – Computational Physics Syllabus – Spring 2003

Instructor: Massimiliano Di Ventra  
Office: Robeson Hall 209-A  
Phone: (540) 231-8729  
E-mail: [diventra@vt.edu](mailto:diventra@vt.edu)

Office hours: Tuesday, Thursday 2:00 – 3:00 p.m. (by appointment)

Recommended Texts: *An Introduction to Computer Simulation Methods*, by H. Gould and J. Tobochnik (Addison Wesley).  
*Computational Physics*, by S.E. Koonin, D.C. Meredith (Addison Wesley).

Also recommended: *Numerical Recipes*, 2<sup>nd</sup> ed., W. Press *et al.*, (Cambridge University Press,1992)

Prerequisites: Knowledge of FORTRAN 90, C or C++ and Unix System.

Lectures and Lab: Thursday 3:30 – 4:45 p.m., Torgensen 2050.

Course Content: The majority of problems encountered in Physics cannot be solved analytically. Therefore, computer simulations are an invaluable tool to reach a profound understanding of physical phenomena. Computational Physics covers every aspect of the numerical solution of physical problems with the aid of the computer. The Course will cover simple but fundamental aspects of computer simulations with application to selected physical systems. The focus will be on the strategy for the solution of numerical problems, their computer implementation and analysis of the results.

Grading: For each subject presented in class the students will develop a computer program. On average, one exercise per week will be assigned that will count 70% of the final grade. At the end of the semester the students will be assigned small research projects that will count 30% of the final grade.

List of Topics: 1) Introduction.  
Principles of computer operation.

- 2) Solution of differential equations.  
Euler, Euler-Richardon, Runge-Kutta methods
- 3) Classical Molecular Dynamics. Verlet algorithm.
- 4) Boundary value and eigenvalue problems.
- 5) Gaussian quadrature.
- 6) Matrix operations.
- 4) Random Processes.  
Monte Carlo methods. Numerical Integration via Monte Carlo.
- 5) Chaotic Motion of Dynamical Systems.
- 6) The Ising model.
- 7) Percolation.
- 8) Fractals.
- 9) Research Projects.