Physics 5794 – Computational Physics
Syllabus – Spring 2001

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

Recommended Text: *An Introduction to Computer Simulation Methods*, 2nd ed., by H. Gould and J. Tobochnik (Addison Wesley, 1996).

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

Prerequisites: Basic knowledge of FORTRAN 77 or 90 and Unix System.
(Books recommended: Ellis, T.M.R. "Fortran 77 programming: with an introduction to Fortran 90 standard", 1990, Addison-Wesley; Michael Metcalf and John Reid, "Fortran 90 explained", 1990, Oxford Science Publications)

Lectures: Thursday 3:30 – 4:30 p.m., Math Emporium.

Lab: Thursday 4:30 – 8:30 p.m., Math Emporium.

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) Random Processes.
   Monte Carlo. Numerical Integration via Monte Carlo.
5) Chaotic Motion of Dynamical Systems.
6) The Ising model.
7) Percolation.
8) Fractals.
9) Research Projects.