# Core Curriculum and Track A (4th academic year)
# Ecole polytechnique, Paris
# September 2000 - July 2001

## 1 The Core Curriculum

A common scientific core composed of the following six courses and a computer science project is required for all students. In mathematics, the core courses are adapted to the specialized tracks and are described there.

### 1.1 Applied Mathematics 1 : Introduction to Probability Theory

- Francis Comets, Professor

Probability spaces, conditioning and independence. Discrete models: Poisson process, Markov chains, branching model. Random variables. Law of large numbers, Central-limit theorem. Gaussian vectors and Gaussian statistics. Least square methods, regression, conditional expectation. Autoregressive processes.

### 1.2 Mathematics 1 (track A) : Mathematical Methods for the Physical Sciences

- Jean-Michel Bony, Professor

Holomorphic functions. Complements of integration, Lebesgue integral. Functional spaces and related convergences. Hilbert spaces. Fourier series, Fourier integral, convolutin. Applications of harmonic analysis. Elements of spectral theory, hermitian matrices, self-adjoint operators in a Hilbert space, compact operators.

### 1.3 Mechanics 1 : Continuum Mechanics

- Jean-Salençon, Professor

Deformation. Kinematics. Principal of virtual work. Sresses. Piola stress tensor. Finite strain and linear thermoelasticity. Navier's equation and Beltrami-Michell's . Variational methods in linear thermoelasticity : minimum principle. Clapeyron's formula.

### 1.4 Physics 1 : Quantum Mechanics

- Jean-Louis Basdevant, Professor

Electron diffraction. Wave mechanics. Wave functions. The Schrödinger equation. Observables. Energy levels. General formulation of quantum mechanics. Two-state systems. Ammonia maser. Stern and Gerlach experiment. Quantization of angular momentum. The hydrogen atom. Spin 1/2. Magnetic resonance. Two spin systems. Quantum cryptography.

### 1.5 Computer Science : Algorithms and Programs

- Robert Cori, Professor

Design of algorithms and programs. Introduction to data structures (arrays, trees, graphs) and algorithms (sorting and searching, parsing, graph theory). Standard programming structures (recursion, divide and conquer, dynamic programming, greedy algorithms, modularity).

### 1.6 Computer Science Project : Programming

- Project Georges Gonthier, Associate Professor

Students carry out, alone or with another student, a software project of about 1000 instructions. The application area must be either another scientific discipline (biology, chemistry, economics, mathematics, mechanics, statistical physics) or an emerging domain in computer science (computer algebra, image processing, interfaces, networks, simulation).

### 1.7 Biology 1 : Molecular Biology

- Sylvain Blanquet, Professor

Composition and folding of proteins. Desoxyribonucleic acid (DNA) as support of heredity. Transcription of the DNA matrix into ribonucleic acid (RNA). The genetic code. Translation of the genetic message into proteins. Control of the expression of bacterial genes. Cellular membranes.

### 1.8 Economy 1 : Introduction to Economic Analysis

- Nicolas Curien and Pierre-Alain Muet, Professor Free trade

The power of the market. Strategic interaction: competition and cooperation. Market deficiencies. Money and exchange. Unemployment. Economic growth

## 2 Track A (emphasizing the Experimental Sciences)

### 2.1 Chemistry 1A: Quantum Chemistry

- Trong Anh Nguyen, Professor

Atomic orbitals. Molecular orbitals. Diatomic molecules. Hückel method. Frontier orbitals. Absolute and relative reactivities. Competition between two sites. Competition between two pathways. Structural problems: research of reactive conformations; relations between reactivity and structural deficiencies.

### 2.2 Physics 2A : Statistical Physics

- Edouard Brézin and Claudine Hermann, Professors

Probabilistic description of macroscopic systems. Statistical entropy. Canonical equilibrium. The relationship to thermodynamics. Identical particles. The Pauli principle. Fermions and bosons at equilibrium. Electronic properties of solids. Thermal properties of electromagnetic radiation.

### 2.3 Chemistry 2A: Organic Chemistry

- Guy Bertrand, Professor

Concepts and strategies for the synthesis of complex molecules. Free radicals. Cycloadditions. Oxidation and reduction of functional groups. Protection and deprotection of reactive functions. Aromatic and heteroaromatic chemeistry. The use of heteroelemnts in synthesis.

### 2.4 MODEX : experimental laboratory work

- Henri Alloul, Professor

Students clarify and deepen their understanding of the theory and models developed in courses in biology, chemistry, electronics, applied mathematics, mechanics and physics via an experimental, research-like approach.