INVESTIGATION INTO COMPLEX SYSTEMS

By Dr. Pier Luigi Gentili*

*Chemistry, Biology, and Biotechnology Department of the University of Perugia

Email: pierluigigentili@gmail.com

Website: http://www.chm.unipg.it/pierluigi

SYLLABUS

• Introduction to Complexity: Natural Complexity and Computational Complexity.

• The Second Law of Thermodynamics: entropy and the arrow of time.

• Violation of the Second Law of Thermodynamics: “Gedanken Experiments” and The Fluctuation Theorem.

• The principles of the Non-Equilibrium Thermodynamics. Flows and Forces. The Linear and Non-linear regimes. Entropy production and evolution criteria for out-of-equilibrium systems.

• Linear stability analysis of stationary states: stable, unstable, and oscillatory states.

• Oscillatory Chemical Reactions, Chemical Waves, Turing structures and Periodic Precipitation.

• More insight into the Non-linear regime: Bifurcations and Chaos.

• Chaos in space: Fractals.

• Strategies to face the challenges of Natural and Computational Complexities.

The course provides four experiments:

(1) ORDER IN TIME: The chemiluminescent oscillatory Orban reaction.

(2) ORDER IN SPACE: Comparing patterns generated by the Belousov-Zhabotinsky reaction and the periodic precipitation.

(3) CHAOS: Photochemical hydrodynamic oscillator.

(4) CHAOS AND COMPLEXITY: Computational experience by using the NetLogo software.