

INVESTIGATION INTO COMPLEX SYSTEMS

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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.