

Faculty of Applied Sciences



INMA2361 Nonlinear systems

[30h+22.5h exercises] 5 credits

This course is taught in the 1st semester

Teacher(s): Rodolphe Sepulchre
Language: French
Level: Second cycle

Aims

An increasing number of engineering applications either exploit or have to deal with nonlinear dynamical phenomena. The course presents the basic mathematical tools used in the modelling and analysis of such phenomena.

Main themes

The course is an introduction to the analysis and synthesis of nonlinear dynamical systems. The mathematical tools are illustrated on different applications, preferentially in the fields of neurodynamics, nonlinear control, and physics. Further specific illustrations are presented by the students at the end of the course.

Content and teaching methods

- Introduction to nonlinear dynamical phenomena
- Introduction to dynamical models in neuroscience
- Multiple equilibria and planar models
- Simple models of neural computation, Hopfield networks
- Gradient systems, Lyapunov functions, stability
- Feedback stabilization of equilibria
- Limit cycles
- Hopf bifurcations, asymptotic methods
- Coupled oscillators, synchronization phenomena
- Input-output tools for the analysis of nonlinear systems
- Introduction to chaos and strange attractors

Other information (prerequisite, evaluation (assessment methods), course materials recommended readings, ...)

Information about the course and a copy of the slides are available at
<http://www.montefiore.ulg.ac.be/systems/SYST017/syst017.htm>

References :

"Nonlinear Dynamics and Chaos", S. Strogatz, Perseus Books Publishing, 1994.

"Spikes, decisions, and actions. Dynamical foundations of neuroscience", H.R. Wilson, Oxford University Press, 1999.

"Nonlinear Oscillations, Dynamical Systems, and Bifurcation of Vector Fields", Guckenheimer, Holmes, Springer-Verlag, 1983.

"Introduction to the theory of neural computation", J. Hertz, A. Krogh, R. Palmer.

Evaluation :

- A final project by groups of two students. The project includes bibliographical research, computer simulations, and an oral presentation.
- A few homeworks during the academic year

Other credits in programs

ELME23/M	Troisième année du programme conduisant au grade d'ingénieur civil électro-mécanicien (mécatronique)	(5 credits)
MAP22	Deuxième année du programme conduisant au grade d'ingénieur civil en mathématiques appliquées	(5 credits)
MAP23	Troisième année du programme conduisant au grade d'ingénieur civil en mathématiques appliquées	(5 credits)