



# Nonlinear systems, chaos and control in Engineering



UNIVERSITAT POLITÈCNICA  
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## 220125 - Els Sistemes No Lineals, el Caos i el Control en l'Enginyeria

**Unitat responsable:** 220 - ETSEIAT - Escola Tècnica Superior d'Enginyeries Industrial i Aeronàutica de Terrassa  
**Unitat que imparteix:** 748 - FIS - Departament de Física  
**Curs:** 2015  
**Titulació:** GRAU EN ENGINYERIA EN TECNOLOGIES AEROESPACIALS (Pla 2010). (Unitat docent Optativa)  
GRAU EN ENGINYERIA EN VEHICLES AEROESPACIALS (Pla 2010). (Unitat docent Optativa)  
GRAU EN ENGINYERIA EN TECNOLOGIES INDUSTRIALS (Pla 2010). (Unitat docent Optativa)  
**Crèdits ECTS:** 3 **Idiomes docència:** Anglès

### Hores totals de dedicació de l'estudiantat

<b>Dedicació total:</b> 75h	Hores grup gran:	30h	40.00%
	Hores aprenentatge autònom:	45h	60.00%

Per week:  
5 hs lectures  
7.5 hs home work



5 hs per week -- 6 weeks.

Friday 18/11 : 8-11 CM

Friday 18/11: 14-16 CM

Thursday 24//11: 9-12 CM

Friday 25/11: 8-10 CM

Friday 2/12: 8-11 AP

Friday 2/12: 14-16 AP

Friday 9/12: 8-11 AP

Friday 9/12: 14-16 AP

Thursday 15/12: 9-12 CM

Friday 16/12: 8-10 CM

Thursday 22/12: 9-12 CM

Friday 23/12: 8-10 CM



## Module 1:

One-dimensional systems

- Linear stability analysis
- Bifurcations



## Module 2:

Two-dimensional systems

- Phase portraits
- Limit cycles
- Hysteresis



## Module 3:

Three-dimensional systems

- Chaotic dynamics
- Lyapunov exponents
- Fractals



- For each module the students will work in small groups on specific projects and will present a written **report** (in the same style of a “lab report”) containing
  - Objectives (explain the problem),
  - Methodology (describe the methods used to solve the problem)
  - Results (explain what have you found)
  - Discussion of results (expected? Unexpected? why? Assumptions and limit of validity of the analysis?)
  - Summary of the conclusions (you can include “open issues” interesting for future work).
- Computer simulations done during the hands-on sessions can constitute part of the projects.
- The final grade will be the **average of the three grades** obtained in the three reports.



- Deadline for presenting the reports:

# Friday January 20, 2017

- Reports received up to 48 hours after deadline will be penalized by 50% and will not be accepted after that.
- Advise: Finalize a first draft of each report as soon as each module finishes.

- Steven H. Strogatz: *Nonlinear dynamics and chaos, with applications to physics, biology, chemistry and engineering* (Addison-Wesley Pub. Co., 1994)
- 2<sup>nd</sup> Edition 2015: electronic book for online reading, available at <http://cataleg.upc.edu>
- Videos: [https://www.youtube.com/playlist?list=PLbN57C5Zdl6j\\_qJA-pARJnKsmROzPnO9V](https://www.youtube.com/playlist?list=PLbN57C5Zdl6j_qJA-pARJnKsmROzPnO9V) (Cornell 2014)
- Additional references will be indicated for each module.

