# Introduction to the course

# System and Control Theory.


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- Reference books:
  - **Slides of the course**.
  - G.F. Franklin, J.D. Powell, A. Emami-Naeini, Feedback Control of Dynamic Systems, Third Edition, Addison-Wesley, 1994.
  - B. C. Kuo, Automatic Control Systems, Prentice Hall.
  - E. Fornasini, G. Marchesini: Appunti di Teoria dei Sistemi, Ed. Libreria Progetto (Padova).
  - G. Marro, Teoria dei Sistemi e del Controllo, Zanichelli.
  - G.F. Franklin, J.D. Powell, A. Emami-Naeini, Controllo a retroazione di sistemi dinamici, Volume II, EdiSES, Napoli, 2005.
  - P. Bolzern, R. Scattolini, N. Schiavoni, Fondamenti di Controlli Automatici, McGraw-Hill Libri Italia, Milano, 1998

- The slides of **System and Control Theory** are available on the web:

**www.dii.unimo.it/∼zanasi/zanasi.htm**

## MAIN TOPICS OF THE COURSE

1. **State space dynamic models.** Dynamic systems described in the state space. State space transformations. Eigenvalues and eigenvectors. Jordan canonical form. Transfer Matrix. Modal analysis of linear systems.

2. **Dynamic modeling and simulation of physical systems.** Dynamic structure of the energetic domains: electro-magnetic, mechanical and hydraulic. Power variables and energy variables. Graphical modeling techniques:: Bond-Graphs e Power-Oriented Graphs. Introduction to Matlab and Simulink.

3. **Stability of linear and nonlinear systems.** Lyapunov stability. Equilibrium points of a system. Linearization in the neighborhood of an equilibrium point. Reduced Lyapunov criterium. Quadratic forms. Direct Lyapunov criterium.

4. **Controllability and reachability.** Definitions of controllability and reachability. Reachability matrix. Reachability standard form. Point to point control of linear systems. Reachability canonical form. State feedback and pole-placement design. Ackerman's formula.

5. **Observability and regulator design.** Definition of observability. Observability matrix. Duality of linear dynamic systems. Standard and canonical observability forms. Asymptotical state observers: open-loop, closed loop and reduced order. Regulator design.

6. **Advanced control techniques.** Interconnected systems and their properties. Sampled-data control systems. System parameters identification. Least square method. Adaptive control (basic elements). Optimal control (basic elements). Sliding Mode Control (basic elements).

7. **Exercitations in laboratory.** Examples of modeling, simulation and control of physical systems using the Matlab/Simulink environment.