Modeling and simulation

Finalità

The aim of this course is to provide the theoretical bases and the practical tools for modelling continuous, discrete, linear and nonlinear systems we can found in industrial processes and services.
We start from the physical analysis and from experimental results describing the process and we derive the transfer function between the input and the output of the process. This analytical function is then implemented on PC by simulation tools like Matlab-Simulink and the final product is a simulator of the original process, which can be used for engineering purposes like design, revamping, training and so on. Finally, the model and the simulator are the basis for optimal designing and verifying the modern control and automation functions.

Programma

1) Industrial processes and general management
- Energetic and economic balance of industrial processes in a real time environment
- Energetic and environmental constraints of industrial processes
- The economic target value of the automation system versus the plant global budget
- The economic impact of the automation performance on the plant annual revenue
- The primary role of the automation system in optimal operating the process
- The knowledge of the process model as a key for optimizing the process performance

2) >From the physical sytem to the mathematical model
- Continuous systems models of continuous industrial processes
- Discrete systems models of deterministic and stochastic discrete processes
- Time response and frequency response of linear systems; the exercises are carried out using the Matlab environment.
- Non linear devices in industrial processes ; the steady state condition and the dynamic behaviour in a large and in a little boundary of the steady state condition.
- Dynamical models of the most important electronic devices for industrial applications

3) Linear analisys of dynamical systems about the equilibrium point
- Frequency analisys and Laplace transform; the exercises are carried out using the Simulink environment.
- Open loop and closed loop systems: the impact of the negative feedback on the closed loop dynamical behaviour
- Simple and asymptotic stability : Nyquist and Bode criteria ; the rootlocus method . Some exercises are carried out using the TFI tool of Matlab
- Transport delays in the loop and their effects on the stability margins.

4) Industrial simulators and their applications in process management
- Discrete system simulators for designing production chains
- Replica simulators for crew training and for in-factory testing of the control devices
- Real time and accelerated time simulators for diagnostic purposes.
- Real time and accelerated time simulators for optimizing processes and for mitigating the consequences of unespected contingencies

5) Process control and automation
- Continuous and discrete control systems : PID controllers, finite states automata, PLC based controllers.
- Designing the plant automation taking into account the dynamical model of the process.
- Human factors in process control : behavioural models, the Rasmussen's cognitive model
- Case studies of industrial process automation

Attività d'esercitazione

The laboratory exercises are carried out bimonthly on individual PCs by student teams (2-3 student per team) making use of simulation tools like Matlab, Simulink, TFI, Statetra, aimed to practically experiment the dynamical behaviour of continuous and discrete processes just presented during the regular lectures. Besides, some practical exercises concern the Field Bus test set , in order to acquire experience on this new technology and on its impact in automation design and in maintenance management.

Modalità d'esame

A final written test is foreseen , followed by an oral test.
Two midterm written tests are foreseen : if the average score is >= 18/30 the final written test is avoided ; if the average score is>= 24/30 also the oral final test is optional .

Propedeuticità

Analisi Matematica ; Fisica Generale ; Fisica Tecnica .

Testi consigliati

A. Cavallaro, R.Setola, F.Vasca:Guida operativa a Matlab, Simulink e Control Toolbox, Liguori Editore, 2000
G. Marro : Controlli Automatici V ed. , Zanichelli, 2004.
D. Carlucci : Teoria dei sistemi ad eventi discreti, UTET 1998.