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Automation and Supervision of Industrial Processes: A New Master Program for Talented Students

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PSPI
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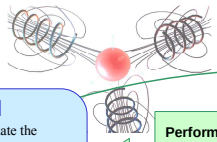
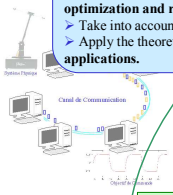


Multi-objective Control

- Provide for a **global system understanding** to evaluate the control limitations and ensure specifications constraints;
- Describe different **model-based** control approaches to fulfill **optimization and robustness** objectives;
- Take into account the **nonlinearities** in the control design;
- Apply the theoretical knowledge to **complex control applications.**



Performance specifications and Quality constraints

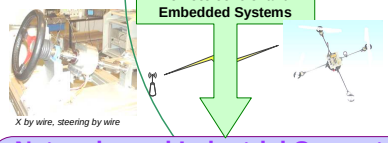
Model-based control of large-scale systems

Modeling and Real-time Applications

- Introduce **multi-physics** modeling of complex systems, with different classes of **models, identification and estimation**;
- Define the concepts, methodologies and tools for the development of **embedded systems applications**;
- Graphical and analytical **softwares** for control applications;
- **Real-time applications** and FPGA: numerical and analogical **data acquisition, filtering and computer-control**.

Networked Control Systems

Remote control and Embedded Systems



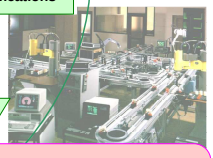
X by wire, steering by wire

Modern Industrial Processes Automation

- **Increased complexity** and need for **communication** capabilities;
- Challenging security, robustness, productivity and **quality specifications**;
- Need for **scalability** and **global system approaches** in every step of the automation design;
- Based on system **integration theory** as much as **technical capabilities.**

Multi-scale models

Optimized design and Quality specifications



Networks and Industrial Computation

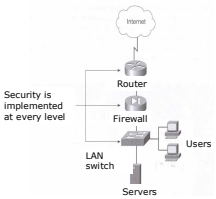
- Learn the fundaments of **networks topology**, architecture **design** and **communication**;
- Implement **safety and security** specifications;
- Become familiar with the different **medium and norms** available (CAN, Ethernet, WiFi…);
- Application to **wireless sensing, industrial automata and field buses.**

Service-oriented network design

Tasks optimization for communicating devices

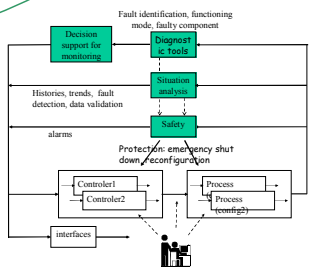
Advanced Discrete Event Systems

- **Management** of interlaced tasks associated with industrial processes;
- Handle tasks **scheduling**, technical data, **logistics** and large-scale **simulations**;
- Introduce the fundaments of **conception and design** for industrial plants.



Safety, Supervision and Diagnosis

- Give the students basic notions situating control loops or data acquisition systems in the **hierarchical context** of **monitoring and supervision**
- Define the concepts for preliminary **safety analysis**
- Describe basic tools for **on line monitoring and diagnosis** of dynamic systems



UE1 – Multi-Objective Control (6 ECTS)

- **Optimal control** (14H)

Linear Quadratic (finite and infinite horizon) and Gaussian Linear Quadratic Control; Optimal filtering (Kalman); Performance analysis and robustness; observer-based control.

- **Nonlinear control** (14H)

Modeling and analysis of non linear systems; State-feedback control; Optimal non linear control; Embedded systems and energy-efficient control.

- **Robust control** (14H)

Sensibility functions, analysis and performance specifications; Performance limitations; Robustness for stability and performances; H_∞ control; Time-delay compensation.

- **Control applications** (20H of **tutorials/lab** classes)

MIMO (water tanks, heat pump) and non linear systems (system with friction, DC-DC converter, magnetic micro actuator); Network Control Systems; Embedded systems and drones.

UE2 – Modeling, Identification, Estimation and Real-Time Control (6 ECTS)

- **Modeling and estimation for control** (24H)

Physical modeling, bond graphs, object-oriented modeling, differential-algebraic models, simulation; Sampling and disturbance modeling; Non-parametric identification; Parameter estimation in linear models; System identification principles and model validation; Nonlinear black-box identification.

- **Labview** (20H class + **lab**)

Data flow programming; Code development for real-time embedded targets and FPGA systems; Data acquisition; Numerical filtering and regulation.

- **Real-time control setups** (30H **lab**)

Modeling of mecatronic systems; Simulation softwares (Matlab, Scilab…); Identification; real-time control algorithms; Network delays estimation and large-scale systems.

UE3 – Advanced Discrete Event Systems (3 ECTS)

- **Scheduling, Logistics and Simulation for DES** (20H)

Scheduling on single and parallel plants; Workshop scheduling; Production management and technical data; Right-on-time and implementation; Logistic function in an industry; Simulation with DES.

- **Petri Nets** (14H)

Modeling and Analysis of discrete event systems; State space analysis; Performance evaluation of timed systems; Application to production systems

UE4 – Networks and Industrial Computation (6 ECTS)

- **Protocols and Networks architectures** (18H)

IEEE norms (network layers and accesses); IP Addressing; Static and dynamic routing; Architectures; Quality of Service.

- **Safety, Security and networks** (18H)

Security of networks: Technologies for security; Cryptology; Security Protocols; Virology; Networks and critical systems, real-time systems, embedded systems; Safe networks (CAN-Open Safe, ASI-Safe, Profisafe…); « Real-time » networks (CAN, switched ethernet, profibus…); Wireless networks (802.15.4, 802.11)

- **Field buses** (18H)

BUS and communication networks for remote systems; CAN, Ethernet and High-speed WiFi systems; Introduction to communicating sensor networks; Conception of industrial systems integrators.

- **Applications of Networks and Security** (15H **lab**)

Commutation (Ethernet /V-lans /Frames anaysis and Wifi); Static and Dynamic Routing; Windows AD /DNS; Security; Filtering and Firewall.

- **Applications of Field Buses and Industrial Automata** (15H **lab**)

CAN BUS on LabView and CompacRIIO, Ethernet BUS on LabView and wireless BUS (Wifi, or Frequency-Shift Keying modulation, ASK in ISM band).

UE5 – Supervision of Industrial Plants (3 ECTS)

- **Safety, Supervision and Diagnosis** (30H)

Safety: basic concepts; Tools for safety analysis; Introduction to diagnosis; Signal processing for diagnosis; Pattern recognition for monitoring and diagnosis; Analytical model-based diagnosis; Causal graphs for supervision

UE6 – Humanities (3 ECTS)

- **English** (24H)
- **Project management** (10H)

UE7 –Mini-project Control and Supervision of Industrial Processes (9 ECTS, 100H)

Team work on a common project with an applied development (i.e.: double inverted pendulum control, heat exchanger, etc.).

UE8 – Industrial Internship (30 ECTS, 5 months)

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