International Graduate School on Control

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Energy-Based Control Design to Face the Challenges of Future Power Systems

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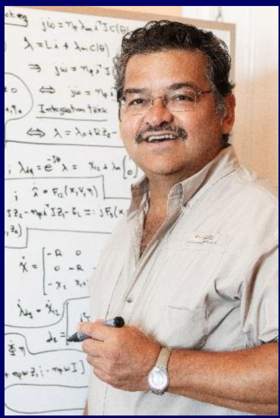
Monterrey, Nuevo Leon, Mexico



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Abstract of the course:

The ongoing transition towards low-carbon power systems renders the current fit-and-forget strategy of renewable distributed generation deployment infeasible and challenges today's power system operation paradigms. In particular, modern power systems are characterized by an increasing number of active network elements with heterogeneous dynamics, resulting in complex networks with mutually interacting subsystems, instead of cause-effect, relations. As a consequence, the classical signal processing viewpoint of control, where the system and the controller are closed and isolated signal processors, and the control objectives are also expressed in terms of signals is highly inappropriate to provide the flexibility, modularity and scalability required in future power system operation.

Instead, to face these challenging problems a new control theory, focused on the energy and dissipation properties of the systems, has been developed in the last few years. The main articulating concepts of this new theory are the property of passivity, which is a reformulation of energy conservation, and the formulation of control as an interconnection of energy exchanging dynamical systems. The aim of these lectures is to introduce the basic concepts of this new theory and their application to emerging problems in low-inertia power systems along with their main components, i.e., power converters, motors, generators and alternative energy sources, such as wind power plants and solar panels.

Theoretical topics:

- Euler-Lagrange and port-Hamiltonian models
- Control by interconnection and PID-Passivity-based Control of nonlinear systems
- Adaptive control of nonlinear and nonlinearly parameterized systems

Practical examples:

- Power electronic systems: power converters and power factor compensation for nonlinear loads
- Control of alternative energy generating systems (wind power plants, fuel-cells and PV units)
- Power systems and microgrids: stabilization of low-inertia systems, distributed passivity-based control applications
- Electromechanical systems: sensorless control of motors, doubly-fed induction generators
- Energy management via control by interconnection