Electric Drives and Power Electronics Group

Master Degree in Digital Automation Engineering

Advanced Electric Drives and Power Converters Systems
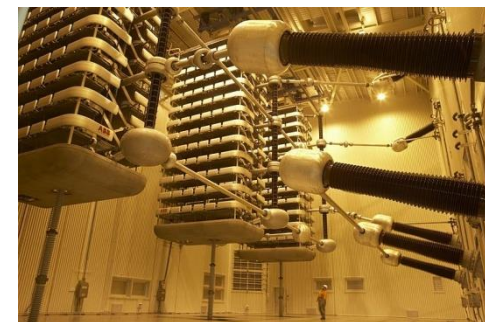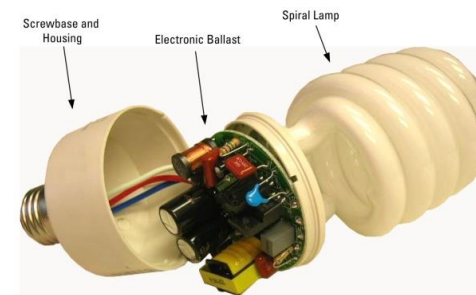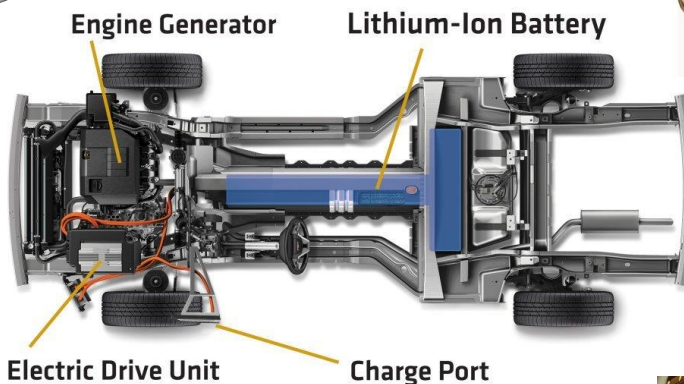
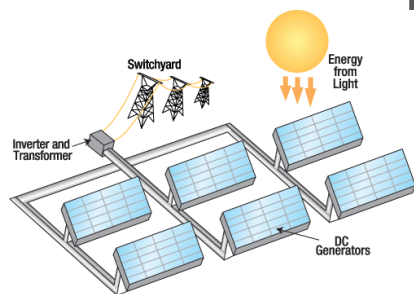Emilio Lorenzani
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Electric drives and Power converters are pervasive

Switchyard

Inverter and Transformer

Energy from Light

DC Generators

Screwbase and Housing

Electronic Ballast

Spiral Lamp

Engine Generator

Lithium-Ion Battery

Electric Drive Unit

Charge Port

Non-exhaustive list: power supplies, battery chargers, home appliances, motor control, industrial automation, lighting, welders, induction heating, wind, solar, UPS, handheld battery tools, pallet trucks, electric vehicles, trains, marine propulsion, submarines, avionics, satellites, telecommunications , HVDC transmission, etc…

Electric Drive in closed loop operation

Power Electronics and motor control

Load Torque

mechanical reducer or kinematics to transform the motion from rotary to linear,...

From Industrial PC, PLC, automotive control unit,......

Reference Signals*

V

T_L

$+$ $-$

ω_m

i

Sensors
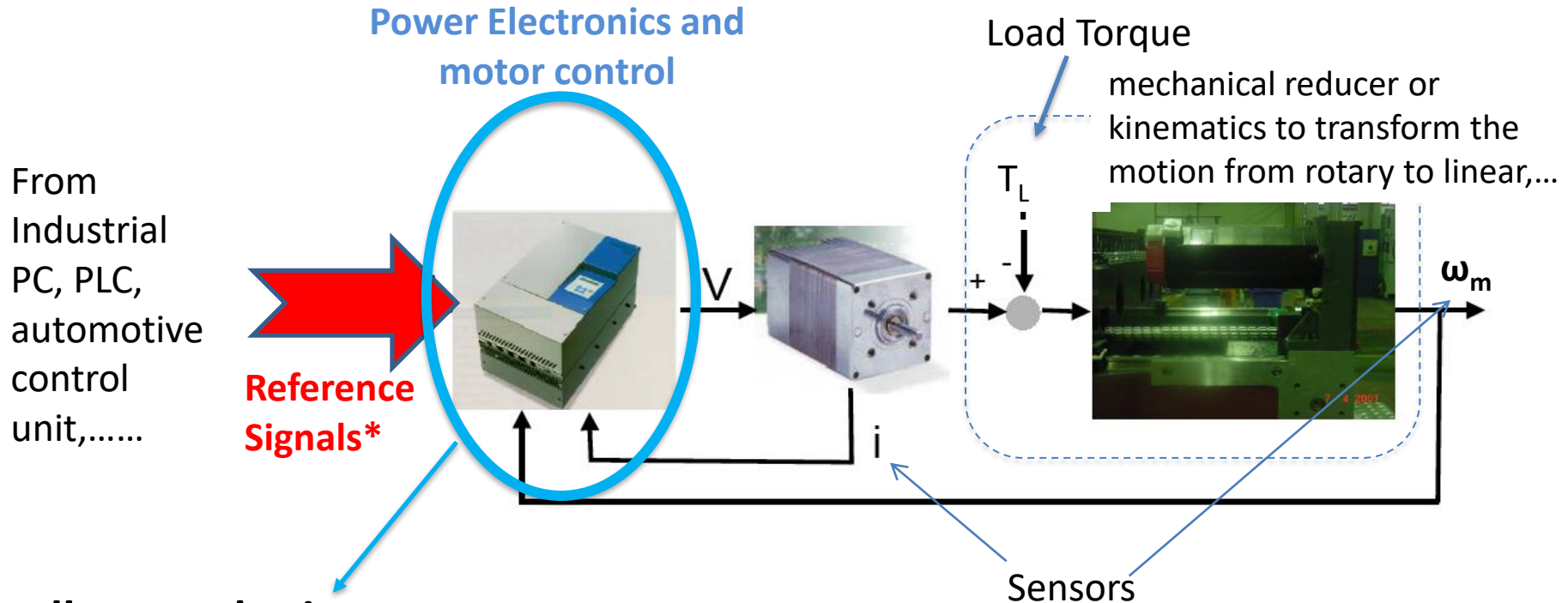
It allow to obtain:

- a robust behavior to external disturbances ensuring constant performance even in the presence of variable load torque.

- high dynamic performance and precision through the feedback control of one or more quantities (for example electric current and speed).

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Course Syllabus 1/2
Prof. Emilio Lorenzani

Electric Drives for:

- Direct Current machines. Closed-loop controls: Bode diagrams, phase margin, bandwidth and tuning of PI controllers.
- DC synchronous brushless machines.
- AC synchronous brushless machines. Theory of the field oriented control. Isotropic and anisotropic machines.
- Induction machine: V/f control and field-oriented control.
- Stepper motor electric drives with open-loop control, microstepping control.

Current/torque, speed and position closed loop controls and implementation on Matlab/Simulink/PLECS.

Sensors used in Electric Drives.

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Course Syllabus 2/2
Prof. Fabio Immovilli

Switching Technology for power conversion.
- Non-isolated DC-DC electronic power converters.
- Isolated DC / DC converters
Design and Simulations in PLECS environment.

Bridge topologies.
- PWM modulations for DC motors.
- PWM modulations for AC motors.
Inverter (DC / AC) converters
Amplitude and frequency modulation index.
Advanced modulation techniques: Space Vector Modulation (SVM)

Determination of losses and thermal modeling of converters
Control of power converters:
- Simulation tools to obtain the transfer function of a converter.
- PWM modulation side effects and interferences.

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Teaching organization

- **Face to face lectures & Laboratory activities**

- **Student reception by appointment**

Prerequisites:

Notions of physics and electrical engineering

Notions of Automatic Controls and Bode diagrams.

Final Assessment:

Oral exam

(intermediate assessment will be available)

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