Title **Azionamenti elettrici I** **Electric Drives I**	Degree **Corso di Laurea Magistrale in Ingegneria Elettronica (DM 270/04)**	Year **2**	Teaching Period **2**	Credits **6**
Teacher: **Roberto Petrella**		Academic year: **2014/2015**		

Objectives:

The course gives both theoretical and practical hints for the control of electric drives in an industrial environment. Particular care is paid to guide the student through the application-oriented choice of the drive. Hardware and software tools for data transmission among drives are also considered.

Acquired skills:

- understanding the terminology and the meaning of parameters in electric drives;
- recognising motors and drives that fit for specific industrial applications;
- reading and understanding technical brochures for the choice of the electric drive;
- carrying out the design of simple speed closed loop controls with both DC and AC drives;
- simulation tools for the dynamic simulation of electric drives.

Lectures and exercises		**hours**
Topics	**Specific contents**	
Introduction to electric drives	Definitions, functional block diagrams. Type of electric motors: dc and ac. Operating regions. Dissipative and regenerative braking. Choice of the motor for a certain application.	4
Power converters for electric drives	Topologies, features and advantages. Electronic power components. Converters: ac-dc, dc-dc, dc-ac (voltage source three-phase inverters)	6
Control system for an electric drive	Historical backgrounds. Evolution from analog to digital control systems.Hardware/software and ASIC/¼;P/¼;C duality. DSP and FPGA based real-time control systems. Analysis of advantages and disadvantages, choice of the type of control system.	2
Electromechanical energy conversion	Principles for electromechanical energy conversion, energy balance. Energy conversion topologies: reluctance, electrodynamical and induction.	4
Dynamics of motor-load system	Block diagrams and transfer function of the mechanical subsystem. Typical trajectories adopted in motion control. Types of loads: active and passive load torques. Calculation of equivalent moments of inertia for common mechanical systems.	6
DC motor drives	Structure, basic block diagram, building diagrams, dynamical model, torque equation and mechanical characteristics of a dc motor. Position, speed and current control. DC motor drives fundamentals and schemes.	8
Exercises for DC motor drives	Exercises on dc motors and drives. Design of the speed controller for a dc motor drive: current and speed control loops.	6
Simulation and implementation of controllers	Design of a (digital) controller for dc motor drives: timing and real-time constraints. Simulation by means of Matlab/Simulink. Analysis of datasheets of commercial dc motors and drives.	4
Stepper motor drives	Operating principles of stepper motors: variable reluctance, permanent magnet and hybrid. Torque production. Feeding schemes. Parameters and characteristics of stepper motors.	4
Use and exercises for stepper motors	Design of a stepper motor drive (choice of the motor). Design of acceleration trajectories. Demo structures of actual motors. Analysis of datasheets of commercial stepper motors and drives.	4
Permanent magnet synchronous motor drives	Structure and principle of operation of permanent magnet synchronous motors (PMSMs). Analysis in sinusoidal feeding conditions. Control strategies. Demo structures of actual motors. Analysis of datasheets of commercial PMSM motors and drives.	4
Three-phase induction motor drives	Structure and principle of operation of three-phase induction motors. Analysis in sinusoidal feeding conditions. Open- and closed-loop scalar control (V/Hz). Equivalent electric circuits and parameters. Field-oriented control basics. Analysis of datasheets of commercial induction motors and drives.	8

Total hours for lectures and exercises	**60**
for exercises only	**12**
Further educational activities	**hours**
Labs	0
Tutorials / Seminars	0
Workshops	0
Guided tours	0
	0
Total hours for further educational activities	**0**
Total hours	**60**

Type of exam: Written

References:

- S. Bolognani, M. Zigliotto, Azionamenti Elettrici, Libr. Progetto, Padova, 1998
- L. Bonometti, Convertitori di potenza e servomotori brushless, UTET, ISBN 88-7933-207-4
- M.H. Rashid, Elettronica di potenza – Dispositivi e circuiti, Volume 1, 3a edizione, Pearson/Prentice Hall, ISBN 9-788871-923475.
- J.M.D. Murphy, F.G. Turnbull, Power Electronic Control of AC Motors, Pergamon Press, ISBN 0-08-022683-3, 1988
- W. Leonhard, Control of Electrical Drives, Springer, ISBN 3-540-41820-2
- N. Mohan, T.M. Undeland, W.P. Robbins, Power electronics: converters, applications and design, John Wiley & Sons, ISBN 0-471-61342-8
- L. Sgarbossa, "Esercizi di Azionamenti Elettrici", Edizioni Libreria Progetto Padova, 2007
- G.R. Slemon, Electric machines and drives, Addison-Wesley, MA, ISBN 0-201-57885-9, 1992
- I. Boldea, S.A. Nasar, Electric Drives, CRC Press, 1998
- A.M Trzynadlowsky, Control of Induction Motors, Pergamon Press, ISBN 0127015108, Sept. 2000

Additional material or information on line http://web.diegm.uniud.it/petrella